ABSTRACTS OF NORTH AMERICAN GEOLOGY

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WALTER J. HICKEL, *Secretary*

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William T. Pecora, *Director*

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

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Ontario Dept. Energy and Resources Management Paper—Ontario Department of Energy and Resources Management Paper. Toronto, Ontario, Canada.

Rev. Geophysics and Space Physics—Reviews of Geophysics and Space Physics. American Geophysical Union. Washington, D. C.

Taxon—Taxon. Journal of the International Association for Plant Taxonomy. Utrecht, Netherlands.

[Tokyo] Natl. Sci. Mus. Bull.—Bulletin of the National Science Museum, Tokyo. Tokyo, Japan.

U.S. Natl. Aeronautics and Space Adm. Tech. Memo.—U.S. National Aeronautics and Space Administration Technical Memo. Clearinghouse for Federal Scientific and Technical Information. Springfield, Virginia.

The abstracts in this issue were prepared by Henry N. Andrews, Jr., Virginia P. Byers, Maurice A. Chaffee, James W. Clarke, Georgianna D. Conant, Howard R. Cramer, Raymond C. Douglass, S. E. Frezon, Richard P. Fischer, Richard E. Grant, Wanda L. Grimes, Elizabeth Hambleton, Joseph E. Hazel, John W. Hosterman, John W. Huddle, Virginia M. Jussen, William R. Keefer, B. H. Kent, Elisabeth S. Loud, J. D. Love, Mildred C. Mead, Donal R. Mullineaux, Virginia S. Neuschel, David A. Ross, E. G. Sable, Elmer S. Santos, Hansford T. Shacklette, Vernon E. Swanson, Dorothy B. Vitaliano, Walter S. White, and Frank C. Whitmore, Jr.

ABSTRACTS

02031 **Abbey, Sydney.** Analysis of rocks and minerals by atomic absorption spectroscopy — Pt. 3, A lithium-fluoborate scheme for seven major elements [with French abs.]: Canada Geol. Survey Paper 70-23, 20 p., tables, 1970.

A new analytical scheme is proposed, whereby silica, alumina, total iron, magnesium, calcium, sodium and potassium are determined in silicate rocks and minerals by atomic absorption spectroscopy. Samples are decomposed by fusion with lithium metaborate, the fusion is dissolved in dilute hydrofluoric acid, and excess fluoride is complexed by the addition of boric acid. The resulting stable solution contains all of the nonvolatile components of the sample, and aliquots are analyzed by comparison with solutions similarly prepared from international reference samples of rocks. Possible extension of the method to other components is discussed. — Author's abstract

09232 **Abbott, D.** (editor). Bibliography of New Brunswick geology (revised edition) — New Brunswick Research and Productivity Council Record 8: Fredericton, New Brunswick, New Brunswick Research and Productivity Council, 105 p., 1969; originally published 1965.

This edition incorporates the published work of the years 1966-69 with the original edition of the bibliography. The subject index includes both listings. — MCM

01906 **Abdel-Gawad, Monem; Silverstein, Joel.** Displacement of San Andreas by active transverse faults [abs.]: EOS, v. 51, no. 4, p. 352, 1970.

09347 **Adams, C. E.; Kregear, R. D.** Sedimentary and faunal environments of eastern Lake Superior, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 1-20, illus., table, 1969.

Bottom sediment samples from 63 stations in eastern Lake Superior contained a 0.5-1.0 cm thick layer of red, arenaceous clay, and suggest a geologic event of regional nature. Upward color change from the red clay to a gray mud indicates a recent increase in productivity and influx of organic matter. Three environments are recognized. The boundary environment is along the south shore and has well-sorted sand and contains a distinctive fauna; the shoal environment is a shallow, areally restricted area isolated from the land, and contains sediments of a wide grain size; much is extremely coarse and lithologically variable. The pelagic environment occupies the entire deep water portion of the basin with sediments ranging from gray clay in the north and central parts to sandy red clay in the south. Coarse material in the sediment of the south is derived from the shoal flanks and the boundary environments via canyon-like features. — *from* Authors' abstract

09175 **Adams, J. W.; Staatz, M. H.** Rare earths and thorium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 245-251, illus., 1969.

Most of the thorium and rare-earth occurrences in Arizona are in pegmatites, the most notable the Rare Metals mine in the Aquarius Cliffs area in Mojave County; several tons of yttrotantalite were obtained during intermittent mining of the deposit. Other rare-earth and thorium minerals such as monazite, gadolinite, euxenite, allanite, and chevkinite have been found in pegmatites in this area. The occurrences of rare earths and thorium in Arizona are shown on a sketch map. — WLG

Adams, John A. S. *See* Civetta, Lucia. 09296

09319 **Adams, Samuel S.** Geology in potash mining and exploration [abs.]: Econ. Geology, v. 64, no. 8, p. 937, 1969.

Adams, William Mansfield. *See* Huber, Richie. 01926

Ade-Hall, J. *See* Baksi, A. K. 01887

02166 **Agarwal, R. K.; Boshkov, Stefan.** Theory and practice gap closes in rock mechanics: Mining Eng., v. 22, no. 2, p. 74-76, illus., 1970.

This article is a review of advances made in rock mechanics during 1969. Subjects reviewed include: (1) laboratory testing of the physical properties of rock, (2) *in situ* testing in boreholes, (3) roof support applications in underground excavations, and (4) mine structure design based on the use of computer-created models. The authors also describe a gap between practical field applications and laboratory applications of theory. — MAC

09476 **Aho, A. E.** Base metal province of Yukon: Canadian Mining and Metall. Bull., v. 62, no. 684, p. 397-409, illus., 1969.

A metallogenic province, lying mostly east of Tintina trench, encompasses most of the base metal deposits of Yukon, as well as other metals. Northwesterly trending arcuate fold belts are modified by regional uplifts, northwest-striking fault trenches, and lesser transverse folding and faulting. Most replacement-type deposits are localized in late Proterozoic to early Paleozoic rocks, and occur near heat sources and suspected regional fault trenches. In the Anvil district, large stratiform iron-lead-zinc replacement deposits lie parallel to gently plunging flexures in a zone parallel to the Tintina trench along the southwest flank of the Anvil batholith. Millions of tons of ore have been eroded from these orebodies. Features suggest an origin from primordial subcrustal sources. More major ore deposits will no doubt be found. — *from* Author's abstract

Aird, C. A. *See* Young, Maurice J. 09463

Aki, Keiiti. *See* Tsai, Yi-Ben. 01992

Akimoto, S. *See* Mizutani, H. 02138

09567 **Alberta University Dept. Geography.** (compiler). Atlas of Alberta: Edmonton, Alberta, Univ. Alberta Press (in association with Univ. Toronto Press), 162 p., illus., 1969.

Although the great bulk of this atlas is nongeologic, there are maps on physical features of Alberta, paleogeography, bedrock geology, surficial deposits, physiography, altitude, glacial geology, ground water, and minerals. The gazeteer is an alphabetical index of place names, rivers, and topographic features. — MCM

09298 **Albu-Yaron, Ana; Mueller, D. W.; Suttle, A. D., Jr.** Chemical separation of cerium fission products from microgram quantities of uranium: Anal. Chemistry, v. 41, no. 10, p. 1351-1353, illus., tables, 1969.

Cerium is separated from the irradiated sample by ion exchange and determined by gamma spectrometry. Recovery greater than 95 percent, usually 99 percent, can be obtained. — AC brief

Aldrich, J. K. *See* Rietman, J. D. 09402

02066 **Alexander, E. C., Jr.; Srinivasan, B.; Manuel, O. K.** I-Xe dating of meteorites [abs.]: EOS, v. 51, no. 4, p. 340, 1970.

02015 **Allen, J. R. L.** The avalanching of granular solids on dune and similar slopes: Jour. Geology, v. 78, no. 3, p. 326-351, illus., tables, 1970.

By combined theoretical and experimental studies, major factors are designated, and quantitatively evaluated, that control the frequency and size of avalanches of loose granular materials on ripples, dunes, Gilbert-type deltas, and scree slopes. These factors are the deposition-rate profile, where grains accumulate faster on the upper part of the slope than the lower; the concentration of settled particles; particle size and density; and the avalanching medium (air or water). Natural sands, glass beads, and organic grains, of various sizes and degrees of sorting, were used in the experiments. Avalanches on screes bordering mountains are very infrequent mainly because of very low rate of sediment supply. — VES

02212 **Althaus, Voy.** Computer program for constructing abnormal formation fluid pressure prediction charts, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. L1-L18, illus., tables, 1970.

This paper describes a computer program which correlates most types of well logs and cutting analysis to fluid pressure information. This allows a formula to be derived that will calculate fluid pressure from log information. The program uses a systematic trial and error method to test several thousand ways to relate logs to pressure. From these trials the user picks the best correlation and a linear regression formula is calculated for the relationship. A chart is drawn on the plotter showing the results. This program has been used to produce most of Humble's pressure prediction charts for the Gulf Coast. — Author's abstract

09582 **Anderson, Alfred T.; Morin, M.** Two types of massif anorthosites and their implications regarding the thermal history of the crust, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 57-69, illus., tables, 1968 [1969].

Two distinct types of massif anorthosite are recognized here: a labradorite type and an andesine type. The labradorite type also contains either hypersthene or olivine, as well as augite, magnetite, and ilmenite. The andesine type contains hypersthene and hemo-ilmenite. External contacts of labradorite anorthosite are difficult to interpret chronologically; however, most of the andesine type are demonstrably intrusive. The melt from which andesine-type anorthosite has crystallized is proposed to have formed by partial fusion of labradorite-type. Crustal conditions prerequisite for melting and consolidation of andesine-type anorthosite prompt speculation that labradorite-type anorthosites may comprise part of the primordial continental crust. — *from* Authors' abstract

09581 **Anderson, Alfred T., Jr.** Massif-type anorthosite, a widespread Precambrian igneous rock, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 47-55, illus., table, 1968 [1969].

Massive anorthosite occurs in widespread Precambrian plutons which range in area from less than a few sq km to tens of thousands of sq km. Within any pluton the predominant rock type may be anorthosite, gabbroic anorthosite, noritic anorthosite, or troctolitic anorthosite. The range of cryptic variation in the compositions of principal minerals is generally small within any single pluton; however, the variation between plutons is large. There is no conspicuous correlation between the sizes of the plutons and either the predominant rock type, the composition of the plagioclase or pyroxene, or their metamorphic age. No evidence can be found that supports the hypothesis that massif-type anorthosite plutons are differentiates of basaltic magmas. A table which lists world anorthosite localities is keyed to a map on the inside front cover of the book. — *from* Author's abstract

09166 **Anderson, C. A.** Copper, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 117-156, illus., tables, 1969.

History of copper prospecting in Arizona from mining by Indians to the present is reviewed; copper deposits are tabulated and shown on a sketch map. In 1965 annual production was 52 percent of domestic total and 18 percent of free world output. Major sources of current production are large low-grade deposits of disseminated or

porphyry copper; in the latter, primary or hypogene minerals are dominantly pyrite and chalcopyrite, but ratios range widely between and in deposits. Important ore bodies (Copper Queen and Christmas mines) have been formed by replacement of favorable limestone beds by copper sulfide minerals. Important production has come from two vein systems — Old Dominion at Globe and Magma at Superior, and massive sulfide deposits largely in Mohave and Yavapai Counties in Precambrian metamorphic rocks, and disseminated minerals in some Colorado Plateaus province sandstones. Copper resources probably total about 60 million tons — about one-half reserves, and one-half undiscovered, or potential resources. — MCM

Anderson, Charles N. *See* Vogt, Peter R. 09608

Anderson, Don L. *See* Jackson, David D. 02102

Anderson, Orson L. *See* Demarest, Harold H., Jr. 02009

02011 **Anderson, Orson L.; Demarest, Harry.** The pressure derivatives of the sound velocities, and Poissons ratios from lattice theory [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

Anderson, Roger N. *See* VonHerzen, Richard P. 01994

09205 **Anderson, Roger Y.; Kirkland, Douglas W.** (editors). Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, 215 p., illus., tables, 1969.

This report containing 14 papers (cited separately) concerns the Rita Blanca lake deposits in Hartley County, Tex. The lake, elliptical and about 6 miles long, was in a deflation basin cut through the caprock of the Pliocene Ogallala Group. One paper describes the geological setting, and three deal with the petrology of the lake sediments, eight with the paleontology of the lake deposits, and one with paleoecology. — HRC

09206 **Anderson, Roger Y.; Kirkland, Douglas W.** Geologic setting of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 3-13, illus., table, 1969.

The Pliocene Ogallala Group generally consists of fine- to medium-grained sand and local gravel into which deflation basins were cut; in one of these the Rita Blanca lacustrine series was deposited. The laminated clays of Rita Blanca lake are overlain by Blanco Formation mammal-bearing sandstones. Several criteria are used to distinguish the fluvial Pliocene from the lacustrine Pleistocene. The flora and fauna of the laminated section are clearly lacustrine, and the lake beds are generally light gray or white whereas the Ogallala sandstone is reddish brown. The maximum *possible* depth of water during deposition of the laminated unit was probably not much greater than 125 feet; the actual depth was probably less. — HRC

Anderson, Roger Y. *See* Kirkland, Douglas W. 09207

09208 **Anderson, Roger Y.; Koopmans, L. H.** Statistical analysis of the Rita Blanca varve time-series, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 59-75, illus., 1969.

Harmonic analysis and studies of component associations by means of the correlation coefficient are used to evaluate changes in this varve-time series. Thickness, color, clay, calcium carbonate, tannin-lignin, Kjeldahl nitrogen, and O-16:O-18 and C-12:C-13 ratio measurements were obtained; data were collected in 5-yr or composite 20-yr units. Varve thickness changes measure combined effects of clay and calcium carbonate components; the clay series exhibits a slight increase in amplitude between 10 and 12 years, and the calcium carbonate a prominent rise at the 22-yr period. Overall dependence of the parameters is examined; thickness and color are complex measures of operating processes in the basin. None of the isotopic correlations indicate association to any other parameters, and power-spectra analyses confirm clay-

carbonate relations derived from Fourier analysis. Cross-spectrum analyses show that the carbonate is principally responsible for variation in coherence. — HRC

Anderson, Roger Y. *See* Kirkland, Douglas W. 09209

09217 **Anderson, Roger Y.; Kirkland, Douglas W.** Paleoecology of the Rita Blanca Lake area, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 141-157, illus., 1969.

The lake occupied a deflation basin during a brief interval in the Pleistocene on what is now the High Plains. Chemical stratification preserved seasonal variations as varves. The depth was between 30 and more than 125 feet. The area around the lake was slightly rolling with a caliche caprock and the drainage basin was mainly in sandstone mantled by chernozem soil. The shoreline vegetation was mesic and was surrounded by xeric flora with a moderately well-developed grass cover. Sage was also common. Fossil and varve evidence suggests the lake was meromictic. Seasonal changes and long-term changes can be identified in the stratification also. A cooler climate than the present is indicated for Blancan time, but no dogmatic statement can be made. — HRC

Andreasen, Gordon E. *See* Zietz, Isidore. 02007

01880 **Andrews, Henry N., Jr.** Index of generic names of fossil plants, 1820-1965: U.S. Geol. Survey Bull. 1300, 354 p., 1970.

This index revises and updates U.S. Geological Survey Bulletin 1013. It is based on the Geological Survey's Compendium Index of Paleobotany and, in accordance with the original plan for the Compendium, diatoms are excluded. Spores and pollen are also omitted in this edition; an attempt has been made to cover other groups of microfossils, but the index is not complete in this area. For each genus a type species, or one that is representative, is cited. A brief notation is given concerning the age, geographic origin, and taxonomic status of most of the fossils. Complete references are given for all citations. It should be emphasized that this is intended as an informational source and not a critical study; no organized authority stands behind the proposed types. — HNA

02173 **Andrews, J. T.** Differential crustal recovery and glacial chronology (6,700 to O BP), west Baffin Island, N.W.T., Canada: Arctic and Alpine Research, v. 2, no. 2, p. 115-134, illus., tables, 1970.

Eight marine strandlines delimited on morphological evidence dip toward 050° at gradients decreasing with age to the present. The maximum ice load was located southwest of Baffin Island, possibly between Baker Lake and Southhampton Island. Five strandlines are associated with stillstands of the western margin of the residual Baffin Island ice cap. Strandlines, dated by reference to a radiocarbon-controlled emergence curve, are reasonable approximations of crustal deformation through time. Correlative geologic-climatic phases along the western margin of the late-glacial Barnes Ice Cap are indicated by moraine evidence. The *Isortoq* Phase, dated about 6,700 B.P., was succeeded by a period of retreat with limited halts. The *Flint* Phase occurred about 5,000 B.P., correlative with growth of the Ellesmere ice shelf and glacier advance elsewhere. Younger prominent moraines are > 1,700, 700 and 250 years old. — *from* Author's abstract

02220 **Annambhotla, Venkata Subramanya S.** Statistical properties of bed forms in alluvial channels in relation to flow resistance [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 9, p. 4147B, 1970.

09229 **Anoshin, G. N.; Yemel'yanov, Ye. M.** Zoloto v magmaticheskikh porodakh Atlanticheskogo okeana (po dannym radioaktivatsionnogo analiza) [Gold in magmatic rocks of the Atlantic Ocean (from radioactivation analysis)]: Akad. Nauk SSSR Doklady, v. 189, no. 5, p. 1107-1110, table, 1969.

Twenty samples of basic and ultrabasic rocks, collected from Iceland and from the Atlantic Ocean floor in the rift zone of the Middle Atlantic Ridge (the Romanche trough and in the Danish Strait) were analyzed by activation methods. A table showing gold content of the samples is included. Basic rocks of the ocean floor are generally richer in gold than analogous rocks of the continents. However, samples from the Romanche area have a low gold content, probably because they were in sea water for a long period of time, and, under certain conditions, the gold became soluble and was leached out. The basic and ultrabasic rocks of the ocean bottoms could be potential sources of gold. — EH

01907 **Anzoleaga, Rodolfo; Ocola, Leonidas C.; Meyer, Robert P.** Western Lake Superior revisited, crustal structure from the integration of gravity and seismic data [abs.]: EOS, v. 51, no. 4, p. 356, 1970.

Appleman, Daniel E. *See* Clark, Joan R. 09405

09311 **Appleyard, Frank C.** Evaluation of a gypsum deposit [abs.]: Econ. Geology, v. 64, no. 8, p. 937, 1969.

Arizona Bureau of Mines. *See* U.S. Geological Survey. 09227

02072 **Armstrong, Augustus K.; Mamet, Bernard L.; Dutro, J. Thomas, Jr.** Foraminiferal zonation and carbonate facies of Carboniferous (Mississippian and Pennsylvanian) Lisburne Group, central and eastern Brooks Range, Arctic Alaska: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 687-698, illus., 1970.

The Lisburne Group carbonate rocks of the central and eastern Brooks Range contain foraminiferal assemblages assigned to zones of late Tournaisian (Osage) to early Moscovian (Atoka) age. Representatives of both Eurasiatic and American cratonic microfaunas permit correlation with the original Carboniferous type sections in western Europe as well as with the standard Mississippian and Pennsylvanian sequences in the Mid-Continent region of North America. Correlation anomalies in the lower part of the sequence are discussed. — Authors' abstract

09275 **Arnold, Chester A.** The fossil-plant record, [Chap.] 8 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 127-143, 1969.

Occurrences and modes of preservation of fossil plants are summarized; evolution of plants is traced from the oldest occurrences of bacteria, algae, and fungi in Precambrian rocks to the essentially modern land floras of the Cenozoic epochs. Marine algal floras, including many reef builders, are dominant from late Precambrian to Silurian. The oldest vascular land plants, pteridophytes, are recorded from upper Middle Silurian; the oldest seed plants, gymnosperms, appeared in earliest Mississippian and culminated in the lush coal-swamp floras of Pennsylvanian and earliest Permian time. By Late Permian, the Carboniferous floras were replaced by ferns and gymnosperms with smaller, thicker leaves — the beginnings of the Mesozoic floras; angiosperms rapidly became dominant in early Late Cretaceous time, marking the beginning of the Cenozoic floras. — VMJ

Arnold, P. W. *See* Riley, D. 09383

02223 **Artyunova, N. M.** Novyye dannyye o krupnykh mestorozhdeniyakh nefti i gaza v SShA [New data on the major oil and gas fields in the U.S.A.]: Geologiya Nefti i Gaza 1970, no. 2, p. 58-59, tables, 1970.

This brief summary of information on the giant oil and gas fields of the U.S.A. is based mainly on papers by Burke and Gardner (Oil and Gas Jour., v. 67, no. 2, 1969); Halbouty (Am. Assoc. Petroleum Geologists Bull., v. 52, no. 7, 1968); and McCaslin (Oil and Gas Jour., v. 67, no. 27, 1969). — DBV

Assad, R. *See* Dugas, Jean. 09484

02014 **Austin, Charles Thomas.** Analysis of an aeromagnetic profile across the Mill Creek syncline, Anadarko basin, southern Oklahoma: Shale Shaker, v. 20, no. 8, p. 144-160, illus., 1970.

The graben of the Mill Creek graben-syncline is a southeastward extension of the Anadarko basin and the anticline a southeastern continuation of the Arbuckle Mountains. The Pennsylvanian Deese Formation crops out in the graben, Precambrian Tishomingo granite is at the surface of the Tishomingo anticline, and northward the Ordovician Oil Creek Formation crops out along the study area. An aeromagnetic profile, flown normal to the Mill Creek structure to determine configuration of the greatly displaced granite fault blocks, showed changes in depth of the Precambrian basement from the southwest end in the Ardmore basin to the northeast end in the Arkoma basin. A quantitative interpretation shows severe overthrusting north of the Tishomingo anticline near the town of Mill Creek. A sedimentary section in excess of 10,000 feet within and south of the surface expression of the Mill Creek graben-syncline is postulated. — *from* Author's abstract

02200 **Austin, S. R.; Hetland, D. L.; Sharp, B. J.** Mineralogy of the Lemhi Pass thorium and rare-earth deposits: Idaho Bur. Mines and Geology Mineral Resources Rept. 11, 10 p., illus., 1970.

These deposits in Idaho and Montana, largest known in the United States, are Tertiary(?) veins and replacements in Precambrian metamorphic rocks of the Belt Series. Quartz-hematite-thorite veins with yttrium-group rare earths dominate the southern part of the district, monazite replacements with cerium-group rare earths the northern part. Base and precious metals are present in some of the thorium-rare earth deposits and in other veins of the district and along its borders. More than 70 mineral species have been reported. Grid patterns in quartz suggest carbonate mineralization may have preceded quartz in many of the veins. The dominant thorium mineral is thorogummite or auerlite, concentrated in limonitic zones by supergene processes. This large thorium deposit contains several thousand tons of rare earths. — *from* Authors' summary

09158 **Averitt, Paul; O'Sullivan, R. B.** Coal, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 59-69, illus., 1969.

In Arizona, all the economically important coal is found in Cretaceous rocks, but one occurrence of coal in Paleozoic rocks, although of no commercial value, is of some scientific interest. Coal, reported to be as much as 20 inches thick (Ransome, 1916) occurs in the Supai Formation of Paleozoic age in Fossil Creek, but its extent is not known; an analysis of the coal showed a yield of about 10,000 Btu (McGoon, 1962). The coal is noteworthy because it is the westernmost occurrence of coal in Paleozoic rocks in the United States and indicates that conditions suitable for the formation of coal existed this far west in Paleozoic times. — WLG

Avery, Otis E. *See* Vogt, Peter R. 09608

09396 **Avila, F. A.; Weaver, D. W.** Mid-Tertiary stratigraphy, Santa Rosa Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 48-67, illus., tables, 1969.

The formations are, from bottom to top: Vaqueros (Oligocene marine sands, 435 feet); Rincon (Oligocene and/or Miocene, marine mudstone, 1860 feet); San Miguel Volcanics and the San Onofre Breccia (basalt and dacite with marine lenses, Oligocene-Miocene, 2100 feet); and Monterey Formation (Miocene clastic rocks and tuffs, 1700 feet). Directional soft sediment structures in the clastic member of the San Miguel Volcanics indicate a dominant southwest paleoslope direction. Numerous faunal zones, based on Foraminifera, are also present and described. — HRC

Ayer, N. J. *See* Gross, D. L. 02118

Ayora, Alfredo. *See* Partheniades, Emmanuel. 09376

09477 **Azzaria, L. M.; Webber, G. R.** Mercury analysis in geochemical exploration: Canadian Mining and Metall. Bull., v. 62, no. 685, p. 521-530, illus., tables, 1969.

The wide interest in the application of the geochemistry of mercury to mineral exploration is leading to the continued development of a variety of analytical methods for the determination of nanogram quantities of this element. The various methods have different degrees of reliability, sophistication and portability. In this investigation, two simple portable instruments were used in geochemical prospecting surveys — an ultraviolet absorption instrument and a similar one modified with gold for the removal of interfering substances. The results show the application of the method to the determination of mercury in soils of different organic content, and rocks, sulfides and air. — Authors' abstract

02073 **Baars, D. L.; Seager, W. R.** Stratigraphic control of petroleum in White Rim Sandstone (Permian) in and near Canyonlands National Park, Utah: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 709-718, illus., 1970.

Gross geometry, cross-stratification, ripple marks, trace fossils, and facies relations of the White Rim Sandstone show that it was deposited in a subaqueous, probably sublittoral marine environment. The formation contains numerous offshore bars with 10 to 20 feet of relief, the result of surf and southeast-flowing longshore currents. The large Elaterite bar with as much as 200 feet of relief and 10 miles long extends north-northwest; its sandstone grades abruptly into fine-grained redbeds on the east, forming a stratigraphic oil trap. Draping of beds over the bar and angular unconformities along the bar margins are pre-Moenkopi (Triassic) in age. The Elaterite bar is almost uniformly saturated with heavy hydrocarbons; asphalt seeps are numerous. Source beds and migration mechanism for the oil are discussed. — EGS

09365 **Bachinski, Donald J.** Bond strength and sulfur isotopic fractionation in coexisting sulfides — A reply [to discussion by E. H. Nickel, 1969, of paper by Bachinski, 1969]: Econ. Geology, v. 64, no. 8, p. 936, 1969.

Nickel (ibid., p. 934-935) is correct in his conclusion that the relative bond strengths are, in decreasing order, FeS_2, CoS_2, and NiS_2. (For original paper *see* ibid., v. 64, p. 56-65, 1969.) — WSW

Baedecker, P. A. *See* Ehmann, W. D. 02019

01901 **Baedecker, Philip A.; Wasson, John T.** The distribution of some major and trace elements in enstatite chondrites [abs.]: EOS, v. 51, no. 4, p. 341, 1970.

09171 **Bailey, E. H.** Mercury, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 226-230, illus., 1969.

About 95 percent of the mercury recovered in Arizona has come mainly from the Ord, Pine Mountain, Rattlesnake, and Sunflower mines in the Mazatzal Mountains district northeast of Phoenix. The larger ore bodies are along steep faults that nearly parallel the foliation of sericitized Precambrian schist. In the Phoenix Mountains district there are several small mercury deposits, consisting of Precambrian metamorphic rocks. Mercury has been found and mined in several places as indicated in a figure, but the low grade of most of the ore has discouraged development. — WLG

09459 **Bailey, E. H.; Blake, M. C.** Tektonicheskoye razvitiye zapadnoy Kalifornii v pozdnem mezozoye, Stat'ya 1 [Tectonic development of western California in the late Mesozoic, Pt. 1]: Geotektonika 1969, no. 3, p. 17-30, illus., 1969; English translation, Geotectonics 1969, no. 3, p. 148-154, 1969.

This article, the first of two by the authors, presents a general analysis of the lithology and structure of the Franciscan complex and the Great Valley sequence, the two late Mesozoic facies present in the Coast Ranges and adjacent Great Valley of California.

The western, eugeosynclinal complex is represented by the Franciscan series which is so complexly deformed that it defies stratigraphic subdivision. The eastern complex is represented by the Great Valley sequence which rests, in the west, possibly on the simatic crust, and, in the east, on a continental type of crust. They were deposited separately in two different troughs, but later the Franciscan complex was possibly thrust under the Great Valley owing to ocean-floor spreading. — EH

09142 **Baker, P. E.** The geological history of Mt. Misery Volcano, St. Kitts, West Indies: Overseas Geology and Mineral Resources, v. 10, no. 3, p. 207-235, illus., tables, geol. maps, 1969.

Mt. Misery, near the northern end of the volcanic Lesser Antilles, is a stratovolcano consisting of a steep cone of andesitic and basaltic lavas and agglomerates flanked by a gently sloping piedmont of pyroclastics and mudflow deposits, with subordinate lava flows; traces of a somma rim suggest a once-much-larger summit crater. Four andesite domes and two small explosion craters are associated with the volcano. Factors controlling deposition of recent Mansion pyroclastics, inferred from grain-size characteristics and estimates of original thickness, indicate pyroclastic-fall deposits erupted from the summit crater and distributed under an easterly wind. The thin Steel Dust Series, containing accretionary lapilli, overlies the Mansion Series on the lower western side of Mt. Misery. Mudflow deposits of various ages, some younger than Steel Dust, are distributed on lower ground. Isolated reports of eruptions in 1692 and 1843 cannot be confirmed, but mild fumarolic activity persists. — *from* Author's abstract

01887 **Baksi, A. K.; York, D.; Ade-Hall, J.** Data on the Pliocene geomagnetic polarity time scale [abs.]: EOS, v. 51, no. 4, p. 271, 1970.

09544 **Baldwin, A. B.** Uranium and thorium occurrences of the north shore of the Gulf of St. Lawrence [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 197, 1969.

09407 **Bancroft, G. Michael; Williams, Paul G. L.; Essene, Eric J.** Mössbauer spectra of omphacites, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 59-65, illus., tables, 1969.

Mössbauer spectra of five omphacites are distinctive and can be used to characterize omphacites having P2 symmetry. The spectra have been fitted to Lorentzian line shapes and consist of 10 lines: 8 due to ferrous doublets and 2 due to ferric doublets. The results indicate that appreciable amounts of Fe^{2+} occupy all four M1 positions; moreover, the intensity of the one well resolved ferrous peak indicates that the Fe^{2+} ordering varies markedly between these five omphacites. These differences in ordering may well reflect differences in temperature and pressure of formation. — *from* Authors' abstract

09414 **Bancroft, G. Michael; Burns, Roger G.** Mössbauer and absorption spectral study of alkali amphiboles, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 137-148, illus., tables, 1969.

Mössbauer, visible, and infrared spectral measurements have been made of alkali amphiboles of the glaucophane-crossite-riebeckite and magnesioriebeckite-riebeckite series. From the computer-calculated areas in the Mössbauer spectra, estimates have been made of the Fe^{2+} site populations of the M(1), M(2), and M(3) structural positions, together with the proportions of Fe^{2+} and Fe^{3+} ions in each mineral. These results agree well with X-ray structure and chemical analysis. The site population estimates together with infrared measurements of the O-H stretching frequencies provide the cation distribution in each mineral. The characteristic colorless-violet-blue pleochroism of alkali amphiboles may be explained by the cation distribution. — *from* Authors' abstract

Banerjee, Subir K. *See* Liebermann, Robert C. 01947

09471 **Baragar, W. R. A.** The geochemistry of Coppermine River basalts [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 209, 1969.

Barazangi, Muawia. *See* Seeber, Leonardo. 01976

02186 **Barlai, Zoltán.** Some principal questions of well logging evaluation of hydrocarbon-bearing sandstones with a high silt/and clay/content — Experience gained by the field application of a new method, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. O1-O64, illus., table, 1970.

In the 10th SPWLA Logging Symposium, Barlai presented a new well-logging evaluation method for evaluation of hydrocarbon-bearing sandstones of high silt and clay content. The present paper investigates some principal questions related to determination of water saturation, hydrocarbon saturation, grain size distribution, and porosity and permeability of reservoir rocks of a general composition. Problems and possibilities connected with the determination of electric resistivity of fully water saturated reservoir rocks are discussed and the process to determine constant quantities figuring in the evaluation functions is outlined. In a given geologic structure results attained by practical application of the method in 10 boreholes are compared with those obtained by other methods. The computerized application of the method is presented also. — *from* Author's abstract

09543 **Bartley, David D.; Matthews, Barry.** A palaeobotanical investigation of postglacial deposits in the Sugluk area of northern Ungava (Quebec, Canada): Rev. Palaeobotany and Palynology, v. 9, nos. 1-2, p. 45-61, illus., tables, 1969.

Peat, associated with raised beaches, reveals: (1) the area has been covered by treeless tundra; (2) the alternation of dated peats and intercalated sands can be interpreted by the climatic scheme worked out for Keewatin — (a) a warm period shown by the peat dated 4,000-2,800 B.P., (b) a cold period, 2,800-1,600 B.P., with windblown sand at one site; (c) a warm and moist period, 1,600-670 years B.P., characterized by much peat; (d) a second cold period — and (3) the development of living *Sphagnum* appears to have followed amelioration of the climate in this century. — *from* Authors' abstract

Bassett, W. A. *See* Liu, L. G. 01949

Bassett, William A. *See* Hammond, Douglas E. 02012

Bateman, Alan M. *See* Wilson, H. D. B. 09218

Battles, Richard F. *See* Borbe:eky, Horst. 09515

Bauman, C. A. *See* Wasserburg, G. J. 09461

09294 **Baun, W. L.; White, E. W.** Clinochlore, a versatile new analyzing crystal for the X-ray region 5-27°A: Anal. Chemistry, v. 41, no. 6, p. 831-832, illus., table, 1969.

Developments of electron microprobe analysis of light elements have been impeded by lack of good analyzing crystals for the X-ray region 10-30 A. Several mineral groups were studied to find a stable mineral, with a 2d of around 30 A, which occurs as large single crystals. Clinochlore and penninite in the chlorite group both appear to be suitable, both are relatively common in nature, but specimens having useful physical dimensions and perfection are rare. Both penninite and clinochlore are monoclinic; perfect [001] cleavage eliminates problems of orientation and cutting. Clinochlore has a first order 2d of 28.392 A. Using clinochlore is equivalent to having four crystals on the spectrometer at once; it is probably most useful for oxygen analysis. — ESL

Bayer, Ernst. *See* Zlatkis, Albert. 09369

02157 **Bayliss, P.; Levinson, A. A.** Clay-mineralogy and boron determinations of the shales from the Reindeer well, Mackenzie River delta, N.W.T., Canada: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 80-83, illus., 1970.

The clay minerals in the shales of the Reindeer D-27 well, Mackenzie River delta, are kaolin (50 percent), illite (45 percent) and montmorillonite-chlorite (5 percent). The uniformity of the clay minerals suggests that the source area has been constant during the Tertiary and Cretaceous. Boron values indicate a change from marine to fresh-water deposition with decreasing age of the shales. — Authors' abstract

02221 **Becher, Albert E.; Meisler, Harold.** High-calcium limestone deposits in Lancaster County, southeastern Pennsylvania, *in* Geological Survey research 1970, Chap. B: U.S. Geol. Survey Prof. Paper 700-B, p. B102-B104, illus., tables, 1970.

Geologic mapping in the Lititz 7 1/2-minute quadrangle, Lancaster County, revealed the presence of the Annville Limestone in the Piedmont province of southeastern Pennsylvania. The Annville is a commercially valuable high-calcium limestone that was reported previously only in the Great Valley of the Valley and Ridge province. Chemical analyses of composite samples from each of four stations in the Lititz quadrangle indicate that the $CaCO_3$ content ranges from 94.2 to 96.5 percent, the $MgCO_3$ content ranges from 1.3 to 3.7 percent, and the silica-alumina content is less than 2 percent. These analyses indicate that the Annville Limestone is a potential source of high-calcium limestone in the Lititz 7 1/2-minute quadrangle. — Authors' abstract

Beck, A. E. *See* Schloessin, H. H. 02013

09465 **Beck, L. S.** Genesis of uranium in the Athabasca region and its significance in exploration [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 197, 1969.

01904 **Becker, V. J.** Halogens and uranium content of tektites [abs.]: EOS, v. 51, no. 4, p. 342, 1970.

01878 **Becraft, George E.; Killsgaard, Thor H.; VanNoy, Ronald M.** Mineral resources of the Jack Creek basin, Madison County, Montana: U.S. Geol. Survey Bull. 1319-B, p. B1-B24, illus., tables, geol. map, 1970.

Most bedrock in the Jack Creek basin is Cretaceous sandstone and shale, intruded along the south side by a series of thick andesite and dacite porphyry sills. The north side of the basin consists of crystalline Precambrian rocks that have been raised by large vertical movement along the steep Spanish Peaks fault. Upturned strata of Paleozoic limestone and quartzite form the crest of the range-front ridge to the west. Glacial deposits derived from mountain peaks to the north and south cover much of the basin floor. Traces of copper and other metals are distributed sporadically along Spanish Peaks fault; no commercial-grade material has been mined from prospects, and none is known to occur in the basin. Samples of stream sediments and rocks are low in metal content, phosphate beds are too thin to be mined profitably, no coal has been found, oil or gas potential is poor, and limestone is too far from marketing areas to be economic. — *from* Authors' abstract

09547 **Béland, Jacques.** The geology of Gaspé: Canadian Mining and Metall. Bull., v. 62, no. 688, p. 811-818, illus., 1969.

Using regional unconformities as principal markers to group geologic events, three periods delimited by two orogenies can be established. The first led to formation of the Taconian orogen, the second to the Acadian, and the third to accumulation of post-orogenic cover. The Taconian orogen includes late Precambrian-early Paleozoic volcanic and detrital rocks in which ultrabasic intrusions were emplaced. Folding is severe, and mineralization is of the Cr-Ni-Cu type. Two sequences of rocks constitute the Acadian orogen. The first grades south from a platform sequence to a less stable assemblage, and the second consists of deposits of synorogenic clastic rocks. Granite intrusions surrounded by aureoles containing Cu-Pb-Zn mineralization accompanied Acadian deformation. Folding was mild in the platform area, severe in the south. Nearly flat-lying Carboniferous terrestrial strata overlie these. — *from* Author's abstract

09525 **Bellayevsky, N. A.** The problem of relationship between geological structures and deep crustal structure [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 404-406, 1969.

09415 **Bell, Peter M.; Roseboom, Eugene H., Jr.** Melting relationships of jadeite and albite to 45 kilobars with comments on melting diagrams of binary systems at high pressures, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 151-161, illus., tables, 1969.

Melting relations for jadeite and albite compositions were studied experimentally. From these data, the melting relations in the system $NaAlSiO_4$-SiO_2 involving jadeite, albite, quartz and nepheline were deduced. In order to obtain the correct phase diagram, we have derived all of the theoretically possible types of P-T-X diagrams for melting at high pressures in binary systems with four solid phases of different compositions and identified the type that fits our system. Details that are too fine to observe experimentally must include a eutectic between jadeite and albite and the incongruent melting of albite to jadeite plus quartz. — Authors' abstract

02136 **Bender, M. L.; Ku, Teh-Lung; Broecker, W. S.** Accumulation rates of manganese in pelagic sediments and nodules: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 143-148, illus., tables, 1970.

Accumulation rates of manganese in sediments of 38 deep-sea cores range from 0.1 to 3.4 mg cm^{-2} 10^{-6} yr^{-1}. Manganese accumulation rates in 5 nodules range from 0.2 to 1.0 mg cm^{-2} 10^{-6} yr^{-1}. In the North Pacific, manganese is apparently incorporated into sediments in association with clay or a related phase; in other ocean basins, no generalizations can be drawn from the data presented here. The similarity between nodule and sediment manganese accumulation rates could be coincidence or could reflect the possibility that nodules and sediments accumulate manganese by the same mechanism. — Authors' abstract

01893 **Bender, Michael; Broecker, Wallace; Gornitz, Vivian; Middel, Ursula.** Accumulation rate of manganese and related elements in sediments from the East Pacific Rise [abs.]: EOS, v. 51, no. 4, p. 327, 1970.

09494 **Benedetti, Duilio.** Correlazioni statistiche tra le grandezze che definiscono l'intensitá di un terremoto [Statistical correlation among the magnitudes which determine the intensities of an earthquake]: Ist. Lombardo Accad. Sci. e Lettere Rend., Cl. Sci. A, v. 108, pt. 3, p. 418-436, illus., tables, 1969.

From analyses of 39 earthquakes registered in California and some theoretical considerations, an attempt is made to correlate the average intensity at a point, the distance of the epicenter from the point, and the magnitude of the earthquake. This relation is employed to express the probability of an earthquake at a given datum point in a seismic zone having an intensity greater or equal to a predetermined value. — VSN

Benninghoff, William S. *See* Zumberge, James H. 09255

Benninghoff, William S. *See* Stevenson, Anne L. 09360

09212 **Benson, Richard H.** Ostracodes of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 107-115, 1969.

The ostracodes existed in a moderately large and deep lake in an area of seasonal droughts. The superabundance of alkaline material in the lake would prohibit all but the most euryhaline fresh-water ostracodes from living on the bottom in the varve-forming area. Northward-flying birds may have infused brackish-water ostracodes which were able to survive when brackishness limited the fresh-water types. The occurrence of ostracode valves in association with certain types of laminae reflects the seasonality of the fresh-water ostracodes. The eggs lay dormant during periods of un-

favorable deposition. Species of three genera — *Limnocythere*, *Candona*, and *Cyprideis* — are described and illustrated. — HRC

01903 **Bentley, Robert D.; Neathery, Thornton L.; Lines, Gregory C.** A probable impact-type structure near Wetumpka, Alabama [abs.]: EOS, v. 51, no. 4, p. 342, 1970.

09503 **Bereskin, S. R.; Edwards, L. N.** Mid-Tertiary stratigraphy, southwestern Santa Cruz Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 68-79, illus., table, 1969.

Mid-Tertiary formations on southwestern Santa Cruz Island are: (1) Vaqueros Formation — paleoecologic and stratigraphic evidence indicate an inner shelf to nonmarine environment (Zemorrian to lower Saucesian); Rincon Formation — a middle to outer shelf bathymetry, shoaling to the east or northwest (Saucesian); San Onofre Breccia — inner to middle shelf with portions possibly nonmarine, thickens and coarsens to the northeast toward a high (Saucesian to Relizian); Monterey and Blanca Formations — Beechers Bay Member of the Monterey was deposited at depths increasing with time from middle shelf to bathyal, paleoslope dipped southwest (Relizian to Luisian and possibly Mohnian). Faunal lists are included. — HRC

09427 **Berg, Dennis W.** Systematic collection of beach data, Chap. 17 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 273-297, illus., tables, 1969.

Approximately 50 observation sites, extending from the Oregon-California boundary to the United States-Mexican border are presently contributing data for study of physical characteristics and littoral processes. These sites represent a wide variety of shore types, beach sediments, geographic orientations, and morphology. It is anticipated that the future expansion of this program will include more detailed description of the California shore. Although not presently programmed, the extension of this study to other coastal areas of the United States where little or no information is presently available would be desirable, and could provide the necessary background for more comprehensive description of the overall behavior of the littoral zone. — *from* Author's abstract

09606 **Berg, R. B.** Petrology of anorthosites of the Bitterroot Range, Montana, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 387-398, illus., tables, 1968 [1969].

Twenty concordant anorthosite bodies occur within an area of approximately 125 sq km just east of the Idaho batholith. The outcrop area of individual bodies ranges from 10 sq m to 2.5 sq km. Average modal composition is 95 percent labradorite (An-51). The variation in composition of plagioclase within a given thin section is large — from An-37 to An-65. Numerous quartz diorite bodies are associated with the anorthosite; they grade from one to the other through compositional continuum. An anatectic origin is tentatively proposed for the anorthosite. More albitic portions of a sillimanite quartzo-feldspathic gneiss were partly melted, producing a quartz monzonitic melt and leaving an anorthositic residuum. The melt was then squeezed out. — *from* Author's abstract

09346 **Berg, T. E.** Fossil sand wedges at Edmonton, Alberta, Canada: Biul. Peryglacjalny, no. 19, p. 325-333, illus., table, 1969.

Fossil sand wedges are described in fluvial deposits locally known as Saskatchewan Sands and Gravels, beneath till in a borrow pit at Edmonton, Alberta. Climatic implications derived from the wedges are: (1) permafrost was present for at least 400 years and possibly 2,400 years prior to ice advance; (2) average annual temperature was at least -5°C or 7°C colder than present; (3) precipitation was less than half of the present precipitation of 40 cm/yr. A ventifacted layer at the top of the surrounding sands and gravels indicates that wind was dominant in sorting material which filled the wedges. — GDC

Berggren, W. A. *See* Cordey, W. G. 02016

09422 **Berry, Michael J.** Seysmicheskiye issledovaniya zemnoy kory v Kanade [Seismic investigations of the Earth's crust in Canada], *in* Internat. Conf. Experts on Explosion Seismology, 1st. Leningrad, 1968, Trans.: Kiev, U.S.S.R., Akad. Nauk Ukrain. SSR Inst. Geofiziki (Izdatel'stvo Naukova Dumka), p. 217-227, illus., 1969.

Results of seismic investigations of the Earth's crust in Canada, which began in 1938, are reviewed. — DBV

02095 **Berry, William B. N.** A local system of automated paleontologic data retrieval and its potential contribution to an eventual nationwide system: Jour. Paleontology, v. 44, no. 3, p. 527-535, illus., 1970.

A set of catalogs produced by the IBM 360/40 computer system is in use at the University of California Museum of Paleontology to facilitate data retrieval from the collections. Catalogs are the most useful form of output from the computer for the Museum. Coding was kept to a minimum. A nationwide system would be a vaulable tool for paleontologists not associated with large collections. — RCD

01890 **Bhattacharyya, P. J.** Spectral analysis of the magnetic profiles across the Mid-Atlantic Ridge at 45°N [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

Biehler, Shawn. *See* Sleep, Norman H. 02188

09246 **Bik, M. J. J.** The origin and age of the prairie mounds of southern Alberta, Canada: Biul. Peryglacjalny, no. 19, p. 85-130, illus., tables, 1969.

Distribution of prairie mounds in the Foremost-Cypress Hills area and in general between Cypress Hills and Edmonton is described and analyzed. Earlier hypotheses of super- or subglacial origin do not explain their occurrence on both glacial and proglacial deposits, nor breaches in the mound rim. Similar to but not identical with collapsed pingos, these Alberta mounds have excess material; low Atterberg limits of the till and high content of montmorillonite in clay fraction suggest subsurface displacement under supersaturated conditions; frost-heave potential could allow thick ice-lenses to form. Under periglacial conditions, ice would segregate earlier and longer beneath depressions of a low-rolling till or lacustrine plain; below advancing permafrost, supersaturation ensues earlier under convexities. Most of the prairie mounds, at least 12,500 years old, are in belts parallel to proglacial lake deposits less than 20,600 years old. — *from* Author's abstract

09556 **Birch, F.** Composition and state of the Earth's interior [abs.], *in* The application of modern physics to the earth and planetary interiors (S. K. Runcorn, editor): London and New York, Wiley-Interscience, p. 299, 1969.

Bird, John M. *See* Dewey, John F. 02141

01898 **Bischoff, James L.; Ku, Teh-Lung.** Pore water geochemistry of Mid-Atlantic Ridge sediments [abs.]: EOS, v. 51, no. 4, p. 333-334, 1970.

Bishop, W. Don. *See* Youmans, A. H. 02214

09344 **Black, Robert F.** Thaw depressions and thaw lakes — A review: Biul. Peryglacjalny, no. 19, p. 131-150, 1969.

In circum-Arctic regions thaw of ground ice, comprising more volume than pore space in the sediments, results in exceedingly abundant depressions and lakes, many of them strikingly large features of the coastal plains and lowlands with continuous and discontinuous permafrost. In North America quantitative data on factors in their origin are meager; a synopsis of principles is given, as well as measurements made of ice content in permafrost. Better known areas described in northern Alaska and Northwest Territories, many of them oriented lakes, are dealt with in separate sections. In this review glacial kettles are excluded; however, thaw lakes may be identical to those resulting from thaw of buried glacial ice; limnology and thermokarst fea-

tures are considered. Lack of stratification or that disturbed by collapse make carbon-14 age determinations difficult; wave and current effects are largely restricted to elongate lakes. — GDC

09348 **Black, Robert F.** Valderan glaciation in western Upper Michigan, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 116-123, illus., 1969.

In western Upper Michigan, various movement indicators — striae, drumlins, drumloid features, end moraines, outwash plains, etc. — reveal several distinct lobes between which relative age relationships may be seen. A probable Valderan boundary, mapped in the Huron Mts. northwest of Marquette, and with breaks westward and southward into Baraga County, is believed also to extend northward to the base of the Keweenaw Peninsula and across it south of Houghton. Several late pulses of the Valderan ice seem to have occurred, in part from centers controlled by topography and local precipitation. Different interpretations are possible within the framework of data on hand. — *from* Author's abstract

Blackburn, Thomas R. *See* Woodrow, Donald L. 09439

01899 **Blackman, Abner; Wolaver, Thomas G.** Geophysical studies of the seamount Balanus [abs.]: EOS, v. 51, no. 4, p. 334, 1970.

Blake, M. C. *See* Bailey, E. H. 09459

09455 **Blake, M. C., Jr.; Irwin, W. P.; Coleman, R. G.** Blueschist-facies metamorphism related to regional thrust faulting: Tectonophysics, v. 8, no. 3, p. 237-246, illus., 1969.

Rocks of glaucophane schist facies occur throughout the world in narrow tectonic belts associated with ultramafic rocks. In California, blueschist rocks in the eugeosynclinal Franciscan Formation of Late Mesozoic age, form a belt of more than 800 km along the eastern margin of the Coast Range province and commonly separated by serpentinite from rocks of an overlying thrust plate. Increasing metamorphism upward toward the thrust fault is indicated mineralogically by a transition from pumpellyite to lawsonite, and texturally by transition from metagraywacke to schist. The blueschist metamorphism probably occurred during thrusting in a zone of anomalous high water pressure in the lower plate along the sole of the fault, a mode of origin different from the generally accepted hypothesis involving extreme depth of burial. Similar belts in Japan, New Zealand, Venezuela, Kamchatka, Ural mountains and New Caledonia might be explained in the same manner. — GDC

02130 **Block, Barry; Dratler, Jay, Jr.; Moore, Robert D.** Earth normal modes from a 6.5 magnitude earthquake: Nature, v. 226, no. 5243, p. 343-344, illus., 1970.

The Earth normal mode spectrum, between 8 and 39 cycles per hour, has been obtained with a 20 dB signal-to-noise ratio for a relatively small earthquake (M = 6.5), using a low-noise broad-band vertical accelerometer of new design. The earthquake occurred in the New Hebrides on October 13, 1969, at 06:56 GMT at 246 km depth. Although not shown in the figures (which go up to 40 c.p.h.) the spectrums for both the earthquake and the ambient noise were taken up to a frequency of 120 c.p.h. At a more favorable site the ambient noise would be lower and enable data to be gathered over a longer time for increased mode resolution. Instruments with a considerably lower Brownian motion limit are under construction. — DBV

01892 **Blumentritt, Russel; Dowling, John J.** A resistivity survey of the southern High Plains of west Texas, rechargeable aquifer thickness [abs.]: EOS, v. 51, no. 4, p. 286, 1970.

09201 **Bodenlos, Alfred J.** Sulfur, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 456-462, 1969.

Arizona has large potential resources of sulfur in its metallic sulfide mineral deposits and in gypsum and anhydrite beds, but both materials require relatively costly processes to convert them into usable sulfuric acid or sulfate fertilizer compounds. Only small occurrences of elementary sulfur have been found, none large enough to be minable; however, there are large deposits of sulfide minerals and some areas are underlain by beds of gypsum and anhydrite. Total potential resources of sulfur are large, both in contained ore and in mine dumps and mill tailings. Only a fraction of the sulfur resources in the form of sulfide minerals is being recovered. Acid produced from sulfide ores contains selenium and cannot be used for fertilizer without further refining. The higher-grade occurrences of gypsum perhaps can be processed as a source of sulfur or sulfur compounds and should be considered as a potential resource of that commodity. — MCM

02139 **Bodvarsson, Gunnar.** Confined fluids as strain meters: Jour. Geophys. Research, v. 75, no. 14, p. 2711-2718, table, 1970.

Earth dilatations due to earth tides and seismic waves cause periodic fluctuations of the fluid pressure within saturated porous formations. Pressures and water levels in wells that are connected with sufficiently confined subsurface fluids are also affected and provide a means of obtaining quantitative data on the earth strain. A theory is given of strain-induced pressure fluctuations in a well-aquifer system, and the results are discussed on the basis of the physical properties of common permeable rocks. The theory is based on a generalized form of Darcy's law involving an inertia term. It is concluded that observations on wells can provide quantitative data on dilatations and that well-aquifer systems can under favorable conditions act as very sensitive strain meters. — Author's abstract

Bohn, Joyce. *See* Raleigh, C. Barry. 01969

09286 **Bonham, Harold F.** Geology and mineral deposits of Washoe and Storey Counties, Nevada, *with a section on* Industrial rock and mineral deposits *by* Keith G. Papke: Nevada Bur. Mines Bull. 70, 140 p., illus., tables, geol. maps, 1969.

Igneous, metamorphic, and sedimentary rocks crop out in Washoe and Storey Counties; pre-Tertiary rocks consist of metasedimentary and metavolcanic rocks intruded by granitic plutons. Widespread Tertiary and Quaternary rocks are the only exposed rocks in the northern part of Washoe County: Tertiary are mostly of volcanic origin with two separate assemblages, Quaternary mainly alluvial and lacustrine sediments. Structure is complex and little understood, but available data indicate two main deformation episodes, late Mesozoic and Cenozoic. Principal metals in Washoe County have been gold, silver, lead, copper and zinc; recorded value is about 4 million dollars. Storey County has a total production of about 400 million dollars, of which 393 million represents silver and gold production from the Comstock Lode. Most metals were recovered from metalliferous ores in Tertiary volcanic rocks. — *from* Author's abstract

09419 **Bonnichsen, Bill.** Metamorphic pyroxenes and amphiboles in the Biwabik Iron Formation, Dunka River area, Minnesota, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 217-239, illus., tables, 1969.

In the Dunka River area the Biwabik Iron Formation has been metamorphosed to the pyroxene hornfels facies by mafic intrusives of the overlying Duluth Complex. The original phyllosilicates and carbonates were converted to pyroxenes and fayalite. Amphiboles were formed mainly from pyroxenes during subsequent retrograde metamorphism. Quartz and magnetite are the most abundant minerals, just as they were before the metamorphism. Oxygen isotopic ratios indicate a maximum contact temperature of 700-750°C. Orthopyroxene is the most abundant ferromagnesium silicate; part of it is inverted pigeonite. Orthopyroxene grains are disproportionately larger than associated minerals. Most of the cummingtonite is paragenetically late. — *from* Author's abstract

Bonnin, Jean. *See* LePichon, Xavier. 01946

09600 **Boone, Gary M.; Romey, William D.; Thompson, Don S.** Oscillatory zoning in calcic andesine — Sodic labradorite relict phenocrysts in anorthosite of Oregon dome and Giant Mountain, Adirondack Highlands, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 317-327, illus., tables, 1968 [1969].

Relict phenocrysts in the anorthosite massifs of Oregon dome and Giant Mountain in the Adirondacks are commonly 1-6 cm long and contain concentric oscillatory zones ranging in composition from An-52 to An-64, as deduced from X-ray, chemical, and optical studies. Zones of bronze iridescence predominate in the central portion of the relict phenocrysts, whereas zones of blue iridescence predominate in their peripheral portions. There is a minimum of four reversals in the zonation. The complexity of the oscillations suggests a magmatic origin for at least the zones in the bronze cores; the broad outer zones may be metamorphic. — *from* Authors' abstract

09515 **Borbereky, Horst; Battles, Richard F.; Goldberg, Donald T.; Haley, James F.; Linehan, Daniel J.** (compilers). Boring data from greater Boston — Sec. 1, Boston Peninsula: Boston Soc. Civil Engineers Jour., v. 56, nos. 3-4, p. 131-293, illus., tables, 1969.

Collected herein are the available logs of borings in the Boston Peninsula not included in earlier publications (1914, 1931, 1961); data were supplied by numerous construction, drilling and engineering companies, and by the U.S. Geological Survey, as well as by the committee members from their own files. The tabulation includes 1,623 borings, giving depths from ground surface, describing soil constituents, and a new column indicating the average consistency of the material in penetration resistance; also given are elevation of existing ground and depth to ground water. An accompanying map shows locations of all borings covered in the tabulation. — GDC

Boshkov, Stefan. *See* Agarwal, R. K. 02166

01894 **Boström, Kurt.** Origin of iron-rich sediments on the East Pacific Rise [abs.]: EOS, v. 51, no. 4, p. 327, 1970.

02132 **Boström, Kurt.** Deposition of manganese rich sediments during glacial periods: Nature, v. 226, no. 5246, p. 629-630, illus., table, 1970.

Study of core P6304-9, in which eight glacial events are recorded in the oxygen isotope ratios, indicates that Mn, Cu, and calcium carbonate are enriched in sediments from most glacial periods in the Caribbean. This could be due to an increase in chemical weathering during these periods caused by pluvial conditions which occurred at lower latitudes simultaneously with glaciations at higher latitudes; or to the transport to the sea, by increased runoff during glacial periods, of laterites and related products formed during the preceding interglacials; or to more complete removal of Mn from sea water during cold periods. — DBV

02222 **Botbol, Joseph Moses.** A model way to analyze the mineralogy of base metal mining districts: Mining Eng., v. 22, no. 3, p. 56-59, illus., tables, 1970.

A binary occurrence model using mining districts and their primary and secondary mineralogy has been established for 30 copper, lead, and zinc mining districts. Mathematical treatment of these data yields a typicality for each mineral for each type of district. Typicality is considered to be the degree of common occurrence of a mineral. The model is further used to compute the degree of mineralogic association between the model and a district external to the model. The Park City, Utah, district is removed from the model and its degree of association with model copper, lead, and zinc districts is computed. — MAC

02120 **Boudin, Andre; Deutsch, Sarah.** Geochronology — Recent development in the lutetium-176/hafnium-176 dating method: Science, v. 168, no. 3936, p. 1219-1220, tables, 1970.

The application of the lutetium-176/hafnium-176 method to gram quantities of minerals containing rare earths is made possible by the development of analytical and

isotope dilution techniques for microgram amounts of lutetium and hafnium. The geological redetermination of the half-life of lutetium-176 ($3.3 \pm 0.5 \times 10^{10}$ years) is in agreement with recent physical measurements. — Authors' abstract

Boulogne, A. R. *See* Corey, J. C. 02216

09366 **Bowie, S. H. U.; Ostle, D.** A comparative evaluation of scintillometric, geochemical, and biogeochemical methods of prospecting for uranium [discussion of paper by N. E. Whitehead and R. R. Brooks, 1969]: Econ. Geology, v. 64, no. 8, p. 933, 1969.

Exception is taken to statements (ibid., no. 1, p. 50-55) (1) that there is difficulty in recognizing apparent anomalies due to mass effect of uneven topography, (2) concerning usefulness of counting methods for laboratory determination of elemental uranium, and (3) that changes in water-flow rate impair reliability of hydrogeochemical prospecting. — WSW

09449 **Boyd, Donald W.; Newell, Norman D.** Limitations of Bernard and Munier-Chalmas system for bivalve hinge notation, *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 2: New York, Geol. Soc. America (and Univ. Kansas Press), p. N908-N913, illus., 1969.

The Bernard (1895-98) and Munier-Chalmas (1895) notation system for designating homologous heterodont hinge teeth has been widely used, but is commonly misapplied in cases where ontogeny and phylogeny are poorly known. A flexible, objective method, modified from Steinmann as interpreted by Dall (1913), is proposed: the two valves are illustrated beak to beak, and the hinge is notated by two lines of symbols which, unlike the Bernard system, provide for inconspicuous or dubious teeth. Review of hinge interpretations in Crassatellacea (Ordovician-Holocene) illustrates the limitations of the Bernard system and the unreliability of grades of hinge complexity (lucinoid and cyrenoid) as bases for separate taxa. Crassatellidae and Astartidae show apparent evolutionary convergence in the hinge from Paleozoic to the present. — VMJ

Boyd, Francis R. *See* Papike, J. J. 09403

09564 **Boyd, Francis R.; Brown, G. Malcolm.** Electron-probe study of pyroxene exsolution, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 211-216, illus., table, 1969.

Electron-probe scans of pyroxenes from large mafic intrusions such as the Bushveld, Skaergaard, and Stillwater show exsolution features ranging from 1 μm to 100 μm or more in thickness. In the augites, Ca-poor pyroxene has exsolved in the form of regularly repeated patterns of clinohypersthene lamellae. Exsolution in the Ca-poor pyroxenes is more complex inasmuch as inverted pigeonites (hypersthene) sometimes contain multiple sets of augite lamellae. Analysis of an augite host-lamella set and a hypersthene host-lamella set shows that the composition of the augite lamellae in the hypersthene host is very close to that of the separate augite host, and that the clinohypersthene lamellae in augite is close to that of the separate hypersthene. Subsolidus equilibrium thus appears to have been maintained over a substantial period during cooling. — *from* Authors' abstract

09323 **Brace, Benjamin R.** Tests for montmorillonite and goethite in southwestern Ohio Pleistocene deposits: Compass, v. 46, no. 2, p. 109-117, illus., 1969.

Samples of Sangamon C-zone soil were tested for montmorillonite, and samples of Wisconsin till and present-day soils were tested for goethite. All samples were from southwestern Ohio and were analyzed by X-ray diffraction and differential thermal equipment. Results of the tests demonstrate that montmorillonite is totally absent or relatively insignificant in the Sangamon C-zone and goethite is relatively insignificant in Wisconsin drift although it may be observed in various amounts in present-day soils. — Author's abstract

09324 **Brace, Benjamin R.; Coppinger, Walter W.** Fossil collecting localities visited at the 1968 Sigma Gamma Epsilon Convention, Cincinnati, Ohio: Compass, v. 46, no. 2, p. 122-129, illus., 1969.

Four fossil collecting localities in the Eden, Maysville and Richmond Groups of Upper Ordovician age were visited by the members of the 1968 Sigma Gamma Epsilon Convention, Cincinnati, Ohio. The biostratigraphy of five additional fossil collecting localities in the Richmond Group is described. The Eden and Maysville Group localities are in northern Kentucky and the Richmond Group localities are in southwestern Ohio. — Authors' abstract

Bracey, Dewey R. *See* Vogt, Peter R. 09608

09450 **Branson, C. C.; LaRocque, Aurèle; Newell, N. D.** Systematic descriptions [subclass uncertain, order Conocardioida Neumayr, 1891], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 2: New York, Geol. Soc. America (and Univ. Kansas Press), p. N859-N860, illus., 1969.

This poorly understood group currently comprises but one genus, *Conocardium* Bronn, 1835, Middle Ordovician to Late Permian in age, cosmopolitan in distribution. The shell is equivalve, anteriorly alate with gaping margin, produced posteriorly in an elongate, tubular rostrum; shell material is thick, inlaid by vertically set partitions forming submerged radial ribs covered by a smooth outer prismatic layer; one or more ridges or septa in each valve curve upward and inward along the ankylosed, edentulous hinge to form conical, forward directed receptables of unknown function. — VMJ

09293 **Breger, Irving A.; Chandler, John C.** Determination of fixed water in rocks by infrared absorption: Anal. Chemistry, v. 41, no. 3, p. 506-510, illus., tables, 1969.

An infrared absorption technique has been developed for the quantitative determination of "fixed water" (H_2O^+) in rocks. Potassium bromide disks containing 2-mg samples are scanned in the 3-μm spectral region and absorption at 2.96μm is determined. Although the exact nature of this peak is not known, other than that it is caused by an interaction between the potassium bromide and hydroxyl groups and water, it can be used for quantitative analysis. Rock samples, other than those containing significant percentages of clay minerals, can be analyzed with a standard deviation of 0.26 percent. — Authors' abstract

Brennan, J. A. *See* Taylor, P. T. 01988

Brett, George W. *See* Weld, Betsy A. 02036

Brewster, Lynn A. *See* Davis, Ronald B. 09253

09368 **Brimhall, Willis H.** Measurement of lead isotopes by differential atomic absorption: Anal. Chemistry, v. 41, no. 10, p. 1349-1351, illus., tables, 1969.

The method uses standard AAS with minor modification; its geochronological promise equals or exceeds that of the Pb-alpha method, but cannot match the precision of mass spectrometric methods. — AC brief

Britt, N. Wilson. *See* Skoch, Edwin J. 09358

09239 **Brobst, D. A.** Barite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 311-315, illus., table, 1969.

Arizona has produced only about 1 percent of the approximately 30 million tons of barite mined in the United States since 1882. Available data on the geology of 75 barite prospects, claims, deposits, and mines in nine counties of Arizona have been summarized by Stewart and Pfister (1960); their major groups of barite prospects and mines are listed in a table and located on a sketch map. Nearly all barite deposits

occur in veins associated with faults, breccias, and fracture zones; most are in igneous rocks, some in sedimentary, and a few in metamorphic rocks. — WLG

09143 **Brochu, Michel.** Pourcentage du matériel de nature cristalline et cristallophyllienne sur le littoral Gaspésien de l'estuaire maritime du Saint-Laurent, de la Baie de Gaspé et de la Baie des Chaleurs [Percentage of crystalline and crystallophyllite material on the Gaspé Peninsula coast, from the St. Lawrence estuary, the Baie de Gaspé and the Baie des Chaleurs (with German abs.)]: Assoc. Française Etude Quaternaire Bull., v. 6, no. 20, p. 207-216, table, 1969.

Several porous formations, consisting of present beach deposits and recent slope deposits on the Gaspé Peninsula, were studied in order to establish variations in percentages of crystalline and crystallophyllitic fragments of western Laurentian origin. On the north shore of the Gaspé Peninsula this percentage decreased from west to east, with size and depth of the St. Lawrence River, and from upstream downward in the river. On the east and south coasts of the peninsula, the percentage of fragments of Laurentian origin decreased to zero, due to the barrier formed by the Notre-Dame Mountains and the Chics-Chocs massif. The data from this study were correlated with those obtained by the author in 1956, further east, where the extension of the Notre-Dame Mountains parallels the middle estuary of the St. Lawrence. — *from* Author's abstract

Broecker, W. S. *See* Bender, M. L. 02136

Broecker, Wallace. *See* Bender, Michael. 01893

02142 **Broecker, Wallace S.; vanDonk, Jan.** Insolation changes, ice volumes, and the O^{18} record in deep-sea cores: Rev. Geophysics and Space Physics, v. 8, no. 1, p. 169-198, illus., tables, 1970.

A detailed curve of ice volume vs. time is needed to test validity of the hypothesis that changes in the Earth's orbital parameters are the cause of oscillations in Pleistocene climate. Absolute ages for glacial moraines and raised coral reefs provide key points but do not allow a continuous curve to be drawn. Existing points are consistent with the hypothesis that O-18/O-16 curves from deep-sea cores provide good approximations to ice volume record, indicating the primary glacial cycle must be sawtoothed in character; gradual glacial buildups over periods averaging 90,000 yr in length are terminated by deglaciations completed in less than one-tenth this time. Secondary oscillations during glacial growth phases average 20,000 yr and during retreats, about 1,000 yr in length. Comparison of ice volume and summer insolation curves for the northern hemisphere indicates rapid deglaciations during times of unusually great seasonal contrast and glacial buildups closely paralleling insolation variations. Dating of a Caribbean core suggests that the absolute time scale adopted by Emiliani for deep-sea cores must be increased by 25 percent. — *from* Author's abstract

09331 **Brogan, Phil F.** Paddling in prehistoric memory — On Oregon's lakes: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 4, p. 24-25, 1969.

The author has for many years taken trips through southeastern Oregon to Great Salt Lake to find terraces cut by waves of lakes which once filled the huge valleys and basins in this area. Highway construction has exposed gravels of old Lake Lahontan in southern Oregon, and shorelines can be seen in long valleys in Nevada. Ancient Warner and Winter Lakes in southeastern Oregon left shorelines and terraces that can be traced. These large lakes formed as the result of a pluvial age influenced by ice sheets to the north and west. Study of the shorelines shows that a dry spell prevailed from 7,500 to 4,000 years ago. — ESL

Brooke, John. *See* Schafer, Charles. 02105

09426 **Brooks, R. R.; Whitehead, N. E.** A comparative evaluation of scintillometric, geochemical, and biogeochemical methods of prospecting for uranium — A reply [to 1969 discussion by Bowie and Ostle, of 1969 paper by N. E. Whitehead and R. R. Brooks]: Econ. Geology, v. 64, no. 8, p. 933-934, 1969.

The procedures and problems described in the original article (ibid., no. 1, p. 50-55) reflect experience with relatively extreme conditions of topography and variations in flow rate. — WSW

09151 **Broom, Matthew E.** Ground-water resources of Gregg and Upshur Counties, Texas: Texas Water Devel. Board Rept. 101, 76 p., illus., tables, 1969.

Gregg and Upshur Counties are underlain by two aquifers, the Eocene Wilcox Group and Carrizo Sand, and the Queen City Sand, that are capable of sustaining additional development. The Carrizo-Wilcox, most productive, underlies all of the area at increasingly greater depths toward the East Texas Embayment; of total pumpage of 3.02 mgd in 1966, 2.84 mgd was from the Carrizo-Wilcox. Water is generally soft, but high chloride content locally may limit development for domestic and municipal uses. The Queen City Sand, which crops out over nearly 90 percent of the area, is relatively undeveloped; an estimated 25 million acre-feet of fresh water is in transient storage, of which 8 million acre-feet theoretically would be available from storage. The water is uniformly low in mineralization except for iron, which makes it less desirable than that from the Carrizo-Wilcox. — *from* Author's abstract

09541 **Brown, A. Sutherland.** Mineralization in British Columbia and the copper and molybdenum deposits: Canadian Mining and Metall. Bull., v. 62, no. 681, p. 26-40, illus., tables, 1969.

Distribution of metalliferous deposits in British Columbia is related to regional geology, especially to the tectonic belts; sketch maps show this relationship for iron, copper, molybdenum, and lead, zinc, and silver. Two main mineralized regions are evident, a northern and a southern. Discussion of metallogenesis is concerned with why the concentrations are where they are, and what correlation there is with other geologic features. Two types of zoning are described. Deposits are divided into five classes: syngenetic, massive sulfide, skarn, porphyry, and magmatic. The first four are described in some detail, porphyry deposits being subdivided into an ordered sequence related to increasing complexity. — ESL

Brown, G. Malcolm. *See* Boyd, Francis R. 09564

02207 **Brown, H. D.; Grijalva, V. E.; Raymer, L. L.** New developments in sonic wave train display and analysis in cased holes, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. F1-F24, illus., table, 1970.

To satisfy optimum-spacing requirements of the Cement Bond Log (short spacing to show attenuation rate of casing arrival more clearly) and the Variable Density Log (longer spacing to show formation arrivals in well bonded intervals), a two-receiver system provides a 3-ft spacing CBL and a 5-ft spacing VDL simultaneously. Recording equipment permits signals to be recorded directly on the same film, thus eliminating problems of separate film processing and depth mismatch. Field examples show this combination can provide a more thorough understanding of cementation quality; cases of microannulus and cement channeling as well as good and poor cement bond can be recognized. Proposed rules which equate CBL-VDL response with hydraulic-seal effectiveness have been derived from comparisons with isolation tests in actual field wells; field examples illustrate interpretation techniques. — *from* Authors' abstract

01891 **Brown, M. C.** Two new methods in karst hydrology [abs.]: EOS, v. 51, no. 4, p. 285, 1970.

02167 **Brown, Severn P.** Burgeoning exploration activity highlights metal mining geology in 1969: Mining Eng., v. 22, no. 2, p. 77-79, 1970.

This article describes numerous metallic mineral deposits that were discovered or were being evaluated worldwide during 1969. Other noteworthy events of 1969 included (1) a number of university-sponsored "short courses" covering different phases of mining and exploration geology, (2) plans for an ore deposits research institute at Pennsylvania State University, (3) various important publications, (4) the

first Penrose Conference dealing with porphyry copper deposits, and (5) the rapid expansion of mining exploration departments, especially within the oil companies. — MAC

02093 **Browne, Ruth G.; Bryant, Albert L.** Plant fossils from the St. Louis Formation in Kentucky: Jour. Paleontology, v. 44, no. 3, p. 520-521, illus., 1970.

Carbonized stem fragments of arborescent lycopods comparable to *Lepidodendron volkmannianum* Sternberg are reported from the basal St. Louis Formation (Mississippian) in north-central Kentucky. — *from* Authors' abstract

Bruening, Wilhelm. *See* Zlatkis, Albert. 09369

Brune, J. N. *See* Hanks, T. C. 01921

Brune James N. *See* Wyss, Max. 02005

09372 **Bruun, Per.** Quantitative tracing of littoral drift, Chap. 20 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 322-328, illus., 1969.

Tests were run at Fernandina Beach, Florida, using fluorescent tracers and bed load traps with automatic doors to determine "bottom creep." Longshore transport as bed load seems to increase with longshore wave energy. The importance of longshore (tidal) current superimposed on the wave-energy current may be noted for the low-energy section. The importance of the longshore and tidal currents combined with stir-up can be seen from the results of higher energy levels. Trough transport predominates over bar transport in the longshore current for the energy levels under consideration. — *from* Author's abstract

Bryant, Albert L. *See* Browne, Ruth G. 02093

Bryant, William R. *See* Cernock, Paul J. 01897

Buchanan, A. S. *See* Walker, Alan L. 09306

Buchanan, A. S. *See* Walker, Alan L. 09364

09591 **Buddington, A. F.** Adirondack anorthositic series, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 215-231, illus., 1968 [1969].

Geological and geophysical data and interpretation are consistent with the hypotheses that: (1) the Adirondack anorthosite series formed from a magma of gabbroic anorthositic composition with substantial amounts of suspended calcic andesine to sodic labradorite crystals; (2) the main massif is a biconvex lens; (3) several unexposed additional masses of the anorthositic series may be present at shallow depth; and (4) anorthosite cores may occur in a gabbroic anorthosite sheath. The hypothesis of flow differentiation with subordinate superimposed fractional crystallization and gravity effects appears to yield a more satisfactory explanation for many of the phenomena than do other hypotheses. The mangerite-charnockite series and pyroxene syenite-hornblende granite series, which are associated geographically with the anorthosite, are inferred to have an origin independent of that for the anorthosite. — *from* Author's abstract

09289 **Bundy, Jerry L.; Carpenter, Albert, 3d.** Feldspar resources of North Carolina: North Carolina Div. Mineral Resources Inf. Circ. 20, 39 p., illus., tables, 1969.

Alaskite deposits of North Carolina's Spruce Pine district account for a large share of feldspar production in the United States. Feldspar is used principally in the glass and ceramic industries. Extensive nonpegmatite deposits found in the Spruce Pine and Shelby districts have completely supplanted the pegmatite deposits of the Cashiers and Bryson City districts as the major source of feldspar in the state. For each of the

major districts where feldspar is, or has been, mined, the general geology, alaskite and/or pegmatites, and selected mines are described. It has been estimated that at the present rate of consumption the state has reserves adequate for several hundred years, mostly in the Spruce Pine district. — MCM

Burnett, D. S. *See* Eugster, O. 02137

Burnham, C. Wayne. *See* Jahns, Richard H. 09304

Burns, R. *See* Malahoff, Alexander. 01952

Burns, Roger G. *See* Bancroft, G. Michael. 09414

Burrell, D. C. *See* Naidu, A. S. 01957

Bushouse, Stephen. *See* Kapp, Ronald O. 09353

09238 **Butler, A. P., Jr.; Byers, V. P.** Uranium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180, p. 282-292, illus., tables, 1969.

Uranium was first mined in Arizona in 1942; production reached a peak of 303,000 tons of ore in 1957 and declined irregularly thereafter. Deposits, which occur in rocks of a wide range in age and lithology, are of penecordant and vein type. Penecordant deposits, mainly in sandstone and conglomerate of continental origin, and most abundant and most generally productive, consist of masses of rock impregnated with uranium minerals. Uranium content ranges from trace amounts to several percent, but average grade has been about 0.29 percent U_3O_8. All but a few deposits are in the Colorado Plateaus province, principally in Mesozoic rocks. One vein-type deposit has yielded a large amount of ore, and several others collectively have yielded an appreciable amount. In 1957 it was estimated that uranium reserves in Arizona were about 1,250,000 tons of ore averaging at least 0.4 percent U_3O_8. — MCM

Byers, V. P. *See* Butler, A. P., Jr. 09238

09148 **Cady, Wallace M.** Regional tectonic synthesis of northwestern New England and adjacent Quebec: Geol. Soc. America Mem. 120, 181 p., illus., tables, 1969.

The complex tectonic relations of northwestern New England and adjacent Quebec are examined in the perspective of a region of 30,000 sq mi on the northwestern side of the Appalachians athwart a major change in trend from northerly in southern New England to northeasterly in northern New England and southern Quebec. Various tectonic features and related bodies of rock are described and interpreted as nearly as possible in order of appearance so as to separate geosynclines, geanticlines, early folds and slides, and concordant calc-alkalic plutons formed in an early tectonic regime from synclinoria, anticlinoria, late folds and thrust faults, and discordant calc-alkalic plutons formed during or soon after the late regime. Biostratigraphic and radiometric evidence for age of sedimentation, igneous intrusion, and metamorphism is reviewed. Major tectonic features are shown on a regional tectonic map. — VSN

Cain, J. C. *See* Zietz, Isidore. 02007

09468 **Calder, Peter N.** Slope stability in jointed rock [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 207, 1969.

Callender, Edward. *See* Edgington, David N. 02134

09428 **Callender, Edward.** Geochemical characteristics of Lakes Michigan and Superior sediments, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 124-160, illus., tables, 1969.

More than 140 sediment samples and their interstitial waters have been analyzed for seven and nine elements, respectively. There is a significant increase in sand-sized quartz in Lake Michigan surface sediment. Most Ca and Mg are combined in carbonate minerals calcite and dolomite. Instability of sedimentary carbonate minerals after burial is reflected in increase of interstitial Ca and Mg over lake water concentrations. Lake Michigan interstitial water is saturated with respect to calcite and dolomite while fluid from Lake Superior sediment approaches saturation with calcite but is undersaturated with dolomite. Interstitial water from all sediments is in equilibrium with kaolinite and approaches saturation with montmorillonite, chlorite, and amorphous silica. Organic matter increases significantly in surface sediment. Fe does not vary appreciably with depth but Mn increases near the sediment-water interface. — *from* Author's abstract

Callender, Edward. *See* Rossmann, Ronald. 09442

Cambray, W. *See* Watkins, N. D. 01997

02065 **Camfield, P. A.; Gough, D. I.; Porath, H.** Preliminary results from geomagnetic deep sounding studies in the northwestern United States and southwest Canada [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

02171 **Campbell, Robert E.** Geophysical exploration moves ahead on two planets [sic]: Mining Eng., v. 22, no. 2, p. 82-87, illus., table, 1970.

This article is a comprehensive review of the utilization of all types of mining geophysical methods during 1969. Included is information on relative frequency and types of methods used, locations of applications, types of deposits sought and discovered, and cost data. Information from industry, governmental surveys, and universities is included. A review of future lunar geophysical programs is included. — MAC

09479 **Canadian Advis.Comm.Rock Mechanics.** Bibliography of Canadian contributions in the field of rock mechanics, 5th Supp., January to December, 1968: Canadian Mining and Metall. Bull., v. 62, no. 686, p. 647-648, 1969.

The bibliography of about 60 citations is divided into three parts: published papers, university theses, and Mines Branch unpublished reports. — ESL

09534 **Cann, J. R.** Petrology of ocean floor rocks [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 543, 1969.

09388 **Cargile, Leslie L.** A case history of the Pegasus Ellenberger reservoir: Jour. Petroleum Technology, v. 21 [no. 10], p. 1330-1336, illus., table, 1969.

The Pegasus oil field is a large multizone field in Midland and Upton Counties, Tex.; the Ellenberger is the deepest reservoir, 13,000 feet, and also the most prolific. The structure is a three-domed anticline trending northeast. Major faults are along the east and west sides of the field, and numerous smaller faults have been detected in electric logs. The Cambrian-Ordovician Ellenberger consists of fractured and brecciated dolomite in randomly distributed zones, divided into six intervals. Concentrations of stylolites are stacked and overlapped, affecting vertical flow. Reservoir performance under water injection, pressure depletion, and gas injection are described, and recovery efficiencies compared. — ESL

Carmichael, C. M. *See* Hayatsu, A. 02123

09137 **Carmichael, C. M.** (editor). Canadian Geophysical Bulletin, V. 22: Ottawa, Ontario, Natl. Research Council Canada, Associate Comm. Geodesy and Geophysics, 307 p., 1969.

This concise review of Canadian activities in geophysics for the year 1969 consists of ten chapters, each containing reports and bibliographies collected by chairmen of subcommittees in the fields of: geodesy and gravity, seismology and physics of the Earth's interior, meteorology, hydrology, geomagnetism and aeronomy, oceanography, glacier research, isotope studies and geochronology, exploration geophysics, and volcanology. — MCM

Carothers, James E. *See* Porter, Christopher R. 02190

Carpenter, Albert, 3d. *See* Bundy, Jerry L. 09289

02170 **Carpenter, Robert H.** USGS leads in the maturing science of geochemical exploration: Mining Eng., v. 22, no. 2, p. 88-90, illus., 1970.

This article reviews geochemical exploration projects undertaken in the U.S. and Canada during 1969. Most geochemical exploration research is being done by the U.S. Geological Survey and the Geological Survey of Canada. Most universities are reluctant to undertake such research; consequently, there is a continuing shortage of specialists in exploration geochemistry. Commercial firms offering geochemical services are growing rapidly, mainly because of increased exploration activities of large companies. Statistical evaluation of geochemical data is becoming increasingly more sophisticated. — MAC

Carr, Roderick A. *See* Wilkniss, Peter E. 02000

Carrillo, Fred V. *See* Kingston, Gary A. 02023

09474 **Carrington, J. K.; Wilton, C. K.** Economic geology of Agnew Lake Mines Limited [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 215, 1969.

02116 **Carroll, Dorothy.** Clay minerals — A guide to their X-ray identification: Geol. Soc. America Spec. Paper 126, 80 p., illus., tables, 1970.

Clay minerals are divided into six groups: kaolinites, micas, montmorillonites, chlorites, mixed layering, and palygorskite-sepiolite. Composition, structure, diffraction pattern, identification, and occurrence are described for: six minerals and an amorphous clay under kaolinites; six minerals under micas; five, well-defined, under montmorillonites; chamosite, swelling and dioctahedral chlorites; and the palygorskite-sepiolite group. Mixed layering, an adjustment to environment, and its X-ray identification are described. X-ray techniques as applied to clay mineralogy are discussed; two tables show the scheme of identification of principal clay minerals and temperatures required in identification. Sections on preparation of clays for X-ray examination, and quantitative estimation of clay minerals in mixtures conclude the paper. — ESL

09546 **Carson, David J. T.** Tertiary mineral deposits of Vancouver Island: Canadian Mining and Metall. Bull., v. 62, no. 685, p. 511-520, illus., tables, 1969.

The metalliferous deposits of Vancouver Island have generally been assigned to the Mesozoic "Coast Range Orogeny;" however, a metallogenic study by the writer has revealed that several important classes are early or middle Tertiary. The porphyry coppers and many gold-quartz veins are within and adjacent to Oligocene-Eocene quartz diorite intrusive complexes. Arsenic and copper arsenic veins have a close spatial relationship to sills and laccoliths of Oligocene dacite porphyry which intrude the late Cretaceous Nanaimo Group. Other deposits of demonstrable Tertiary age include a molybdenum stockwork related to a relatively potassic Eocene plug and a few small copper-skarn occurrences. Some copper stockworks and a mercury deposit are probably also Tertiary. The copper deposits of previously recognized Tertiary age are those of the Sooke area that occur in Eocene basalts and Oligocene gabbros. — *from* Author's abstract

Carter, Claire. *See* Churkin, Michael, Jr. 02084

Case, Gerard R. *See* Lundberg, John G. 02150

Casey, Raymond. *See* Chavan, André. 09497

Cashion, W. W. *See* Cooper, Byron N. 02165

09453 **Castaño B., Leopoldo.** Buen futuro petrolero podría tener el Golfo de Panamá [with English abs.]: Petróleo Interamericano, v. 27, no. 10, p. 58, 60-62, illus., 1969.

The Gulf of Panama, on the Pacific side of the country, is considered by many geologists to be the last sedimentary basin on the western side of the Western Hemisphere. It is very probable that wildcat drilling will start there in the near future. — Author's abstract

09454 **Castaño B., Leopoldo.** Intensifican el cateo en Trinidad [with English abs.]: Petróleo Interamericano, v. 27, no. 11, p. 53-54, 57, illus., 1969.

The recently discovered oil and gas off eastern Trinidad, plus the very encouraging results of seismic studies conducted off-shore between Trinidad and Tobago, give the country a very good chance of reversing the declining rate of production. — Author's abstract

Cathles, L. *See* Kalliokoski, J. 09495

01897 **Cernock, Paul J.; Bryant, William R.** Porosity, bulk density, and the velocity of compressional waves in Gulf of Mexico sediments at simulated depths [abs.]: EOS, v. 51, no. 4, p. 333, 1970.

09612 **Chadwick, Brian.** Patterns of fracture and dyke intrusion near Frederikshaab, southwest Greenland: Tectonophysics, v. 8, no. 3, p. 247-264, illus., 1969; *reprinted as* Grönlands Geol. Undersögelse Misc. Paper 71, 1969.

Patterns of fractures and basic dikes in a 200-km area of pre-Ketilidian gneiss (about 2,500 m.y. old) are analyzed. Most fractures are late pre-Ketilidian, intruded by four generations of dolerite dikes; three denoted MD are late pre-Ketilidian, the fourth, TD, is Mesozoic. MD-1 dikes intruded shear fractures formed under a maximum compressive stress trending 100°-110°, which later changed to near 90° with two major wrench faults trending 120°-125° and sinistral offsets — an effect? of anisotropic gneiss fabric. Splay faults at the end of one of these shears are related to predicted secondary faults. MD-2 dikes, after the wrench faulting, occupied shear fractures complimentary to these displacements. Riedel faults, developed during faulting in zones between these shears, are occupied by MD-3 dikes en echelon. After relative quiet, TD dikes intruded, probably under tensional conditions, reactivated fractures parallel to the coast. — GDC

09281 **Chaloner, W. G.** Triassic spores and pollen, [Chap.] 14 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 291-309, illus., 1969.

The Mesozoic floras began during the Permian rather than at the Permian-Triassic boundary. Of the gymnosperm groups prominent in Mesozoic floras — conifers, cycadophytes, ginkgos, Caytoniales, pteridosperms — all but Caytoniales had appeared by Late Permian. Pteridophytes were less important, owing to increased aridity, but by the close of the Triassic, ferns had again increased, reflecting return to more humid conditions. Spores and pollen are preserved differently from corresponding macrofossils, so their abundances and ranges may be different. Affinities of triradiate miospores and megaspores with lycopod, sphenopsid, and fern fructifications, and saccate and monocolpate pollen with gymnosperms, are discussed. Important Triassic palynomorph genera are discussed in morphologic groups, and their stratigraphic ranges are shown. — VMJ

Chan, Kwan M. *See* Sayles, Fred L. 01972

Chandler, John C. *See* Breger, Irving A. 09293

Chau, Y. K. *See* Chawla, V. K. 09429

09497 **Chavan, André; Keen, A. Myra; Cox, L. R.; Fleming, C. A.; Casey, Raymond; LaRocque, Aurèle; Turner, Ruth D.; Dechaseaux, Colette; Perkins, B. F.; Coogan, A. H.** Systematic descriptions [subclass Heterodonta Neumayr, 1884], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 2: New York, Geol. Soc. America (and Univ. Kansas Press), p. N491-N817, illus., 1969.

Heterodonta (Ordovician-Holocene) (1001 genera, 582 subgenera described), are marine eulamellibranchs, generally with hinge plate and distinct cardinal and lateral teeth, nonnacreous shell structure, and fused, siphonate mantle margins. The polyphyletic order Veneroida (789 genera, 529 subgenera), with 19 superfamilies including Lucinacea, Leptonacea, Tellinacea, Veneracea, and the order Myoida, with four superfamilies including Pholadacea, comprise ancient forms related to actinodonts and many extant nestling or burrowing forms. The extinct Hippuritoida are thick-shelled aberrant pachydonts — the Megalodontacea and the attached, strongly inequivalve Hippuritacea or rudists (Jurassic-Cretaceous, 115 genera), important index fossils, commonly reef forming, in low paleolatitudes. Functional morphology and evolution of rudists are interpreted. — VMJ

09429 **Chawla, V. K.; Chau, Y. K.** Trace elements in Lake Erie, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 760-765, illus., tables, 1969.

Of 11 elements studied in Lake Erie, the concentrations of Cd, Cr, and Co were below the detection limits. The annual average values of Fe, Mn, Sr, and Cu of surface waters were comparatively higher than the average of some fresh water lakes of North America. Concentrations of Zn, Ni, Li, and Pb were quite comparable. The horizontal distribution of Cu, Zn, Ni, Li, and Pb were uniform in the main water body of the western, central, and eastern basins. Iron and Mn were higher in the western and central than the eastern basins, however; Sr, on the contrary, was lower in the western basin. The measurements were made between June and October 1967. — *from* Authors' abstract

Cheng, Ku-Chuan. *See* Thompkins, R. W. 09489

Cherry, J. T., Jr. *See* Kisslinger, Carl. 01940

02194 **Christ, C. L.; Hostetler, P. B.** Studies in the system MgO-SiO_2-CO_2-H_2O — [Pt.] 2, The activity-product constant of magnesite: Am. Jour. Sci., v. 268, no. 5, p. 439-453, illus., tables, 1970.

Experimental determination of the activity-product constant of magnesite at 90°C yields the value $K_M = 10^{-9.1 \pm 0.3}$. Values of K_M were also calculated for temperatures from 0° to 200°C. K_M is $10^{-7.6}$ at 0°C and diminishes monotonically to $10^{-11.7}$ at 200°C. The calculated 90° value is $10^{-9.3}$, in good agreement with the experimental value. The data indicate that magnesite, rather than the hydrous phases, hydromagnesite or nesquehonite, is the stable form of magnesium carbonate under Earth surface conditions. This is in accordance with observations of natural occurrences of these minerals. — *from* Authors' abstract

02203 **Christensen, Nikolas I.** Compressional-wave velocities in basalts from the Juan de Fuca Ridge: Jour. Geophys. Research, v. 75, no. 14, p. 2773-2775, illus., tables, 1970.

Compressional-wave velocities are reported to pressures of 10 kb for three samples of tholeiitic basalt dredged from the Juan de Fuca Ridge. Average velocities for air-dried samples range from 3.90 kmps at 0.2 kb to 6.44 kmps at 10 kb. Low-pressure velocities are increased by as much as 25 percent with water saturation, whereas velocities above 3 kb are only slightly increased. Compressional-wave velocities for

the basalts are clearly lower than seismic refraction velocities for lower oceanic crustal rocks near the Juan de Fuca ridge. The water-saturated basalt velocities are, however, within the range of reported velocities for layer 2 of the oceanic crust. — Author's abstract

02010 **Chung, Dae-Hyun.** Method for estimating the pressure coefficients of P and S velocities in solids [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

02084 **Churkin, Michael, Jr.; Carter, Claire.** Early Silurian graptolites from southeastern Alaska and their correlation with graptolitic sequences in North America and the Arctic: U.S. Geol. Survey Prof. Paper 653, 51 p., illus., tables, 1970.

A succession of graptolite faunas across the Ordovician-Silurian boundary has been discovered in North America; the earliest Silurian graptolite zones are described for the first time. These new collections of Lower Silurian graptolites are from dark shales in southeastern Alaska and Nevada. The occurrence of Silurian graptolites in western North America is reviewed, and the Alaskan graptolite faunas are correlated with other graptolitic successions in North America and the Soviet Arctic. The Alaskan graptolite species and zonal succession are remarkably similar to that in the Birkhill shales of Scotland, the type section for the standard Lower Silurian graptolite zones. From Alaska, graptolite assemblages equivalent to the zones of *Akidograptus acuminatus*, *Monograptus cyphus*, and *M. gregarius* are recognized and illustrated. In addition, 21 new species are established. — *from* Authors' abstract

02143 **Cisne, John L.** *Constantina pulchra*, an unusual proetid trilobite from the Devonian of Pennsylvania: Jour. Paleontology, v. 44, no. 3, p. 522-523, illus., 1970.

Constantina pulchra n.gen., n. sp. [from Conewango Stage beds at Warren, Pa.] is a Late Devonian proetid trilobite markedly similar to odontopleurid trilobites. As contrasted with typical and primarily benthic proetids, its unusual features seemingly relate to convergence with odontopleurids during the Late Devonian-Early Carboniferous proetid radiation, and quite possibly relate to adoption of planktonic habits. — Author's abstract

09296 **Civetta, Lucia; Gasparini, Paolo; Adams, John A. S.** Determination of potassium-40 by gamma ray spectrometry for potassium-40/argon-40 geochronology: Anal. Chemistry, v. 41, no. 10, p. 1319-1322, illus., tables, 1969.

K-40 can be routinely determined by this method with a precision and accuracy satisfactory for most minerals used in K-Ar work if at least 1-2 grams of sample are available. — AC brief

Clark, Joan R. *See* Papike, J. J. 09403

09405 **Clark, Joan R.; Appleman, Daniel E.; Papike, J. J.** Crystal-chemical characterization of clinopyroxenes based on eight new structure refinements, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 31-50, illus., tables, 1969.

Comparison of new crystal structure refinements for spodumene, $LiFeSi_2O_6$, synthetic ureyite, acmite, diopside, augite, C2/c omphacite, and P2 omphacite with published refinements for other pyroxenes indicates that the structures are strikingly similar. The end-member pyroxenes are ordered within the limits of resolution. Bonding can be explained in terms of an essentially ionic model without invoking additional covalent effects. Except for P2 omphacites, the charge and size of the M2 cations determine the structure type. — *from* Authors' abstract

Clark, Joan R. *See* Papike, J. J. 09413

02077 **Clark, Stuart K.** Fritz Love Aurin (1891-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 807-808, portrait, 1970.

Clayton, Robert N. *See* Onuma, Naoki. 01963

Clowes, R. M. *See* Kanasewich, E. R. 01937

Clowes, R. M. *See* Kanasewich, E. R. 09574

Coats, C. J. A. *See* Kilburn, L. C. 09222

01886 **Cochrane, N. A.** Geomagnetic deep sounding in western Canada, a reinterpretation [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

Coleman, R. G. *See* Blake, M. C., Jr. 09455

Collinson, Charles. *See* Gross, D. L. 02118

Coogan, A. H. *See* Chavan, André. 09497

Cook, C. F. *See* Lawson, B. L. 02184

09573 **Cook, Kenneth L.** Active rift system in the Basin and Range province, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 469-511, illus., 1969.

Recent gravity, seismic, and heat flow data in Utah and New Mexico are reviewed which define the active rift system in the eastern Basin and Range province, a possible part of the extension of the East Pacific Rise into western North America. A mantle convection current rising below the eastern Basin and Range and flowing westward is postulated as the mechanism of late Cenozoic vulcanism and diastrophism; the active rift system lies over the region of tension above the upwelling convection currents. In the region of translation and compression, the westward-moving mantle dragged the continental crust in the California region causing a large block to move westward 50-100 km into the Pacific Ocean between landward projections of Mendocino and Murray fracture zones. Movement occurred along transcurrent and/or transform faults. Right-lateral movement of the San Andreas zone is explained by a second, north-trending mantle current with velocity gradient increasing southwestward. — VSN

02165 **Cooper, Byron N.; Cashion, W. W.** Relation of the Pulaski and Seven Springs faults in southwestern Virginia: Am. Jour. Sci., v. 268, no. 5, p. 385-396, illus., 1970.

Recent mapping in the Marion-Rural Retreat area has shown that the Pulaski and Seven Springs faults are one continuous fault zone which passes through the narrow topographic and structural corridor between Atkins and Marion. Detailed mapping has also shown that the Honaker Dolomite may not grade into the Elbrook Formation. The Honaker is on one fault block and the Elbrook on another. — HRC

02100 **Cooper, G. Arthur; Grant, Richard E.** New name for brachiopod homonym and citation of types: Jour. Paleontology, v. 44, no. 3, p. 579, 1970.

For "New Permian brachiopods from West Texas": *Texarina* replaces *Texasia* Cooper and Grant, 1969 (*non* Reeside, 1932); *Petasmatherus opulus* Cooper and Grant, 1969 is selected as the type species of *Petasmatherus*; and reference, horizon, and locality data are given for *Chonetina? rostrata* Dunbar and Condra, 1932, the lectotype designated for *Sulcataria* Cooper and Grant, 1969. — REG

Coppinger, Walter W. *See* Brace, Benjamin R. 09324

02016 **Cordey, W. G.; Berggren, W. A.; Olsson, R. K.** Phylogenetic trends in the planktonic foraminiferal genus *Pseudohastigerina* Banner and Blow, 1959: Micropaleontology, v. 16, no. 2, p. 235-242, illus., 1970.

A quantitative study of *Pseudohastigerina* Banner and Blow, 1959, in tropical to midlatitude regions indicates the following phylogenetic trends: The derivation of *P. micra* from *P. wilcoxensis* during the middle Eocene by gradual compression of the test; and the reduction in test size in the late Eocene-early Oligocene (*P. micra*→ *P.* cf. *naguewichiensis*). — Authors' abstract

02216 **Corey, J. C.; Boulogne, A. R.; Horton, J. H.** Determination of soil density and water content by fast neutrons and gamma rays: Water Resources Research, v. 6, no. 1, p. 223-229, illus., tables, 1970.

Sequential measurements of gamma and fast neutron attenuation were used for nondestructive determination of both soil density and water content of soil samples. Soils containing known amounts of water were packed into 22.5-cm diameter cylinders to a depth of about 9 cm. Measurements were made of attenuation of fast neutrons from a 3-μg Cf-252 source and attenuation of gamma rays in a collimated beam from a Cs-137 source. The attenuation was used to calculate the soil density and water content of these samples. The mean difference between the calculated and known water contents was 0.006 g/cm^3 with a standard deviation of 0.010 g/cm^3; the mean difference for soil density was 0.010 g/cm^3 with a standard deviation of 0.017 g/cm^3. Calculations based only on counting statistics show that an attenuation method using a combination of gamma and fast neutrons is better than a method using two gamma energies. — Authors' abstract

01896 **Couch, Richard W.** Geophysical observations of Explorer ridge and trough [abs.]: EOS, v. 51, no. 4, p. 331, 1970.

Couch, Richard W. *See* Gemperle, Michael. 01913

02189 **Cox, John W.** The high resolution dipmeter reveals dip-related borehole and formation characteristics, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. D1-D25, illus., 1970.

The four-arm High Resolution Dipmeter system provides several data not previously recorded. Dipmeter data are recorded digitally on magnetic tape as well as on photographic paper or film; curve correlation and dip computation is computer processed, providing both high-density dip calculations for environmental studies and lower-density calculations for description of complex structures and near-vertical bedding planes. Excellent resolution of dip combined with the dual-caliper feature of the tool has made possible a better understanding of interrelations between structural dip, hole drift, and direction and hole elongation. Comparison of relative resistivity levels of the four dip curves indicates some formations have a preferential direction of low resistivity. The effect on appearance of IE logs in steeply dipping anisotropic shales shows good correlation with computed dipmeter results. — *from* Author's abstract

09443 **Cox, L. R.; Nuttall, C. P.; Trueman, E. R.** General features of Bivalvia, *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N2-N129, illus., 1969.

Main characters are outlined for the class of aquatic bivalve mollusks herein designated as Bivalvia Linne, 1758 (also known as Pelecypoda and by other names). Discussed in somewhat greater detail are: biology, including ecology; morphology of soft parts; morphology of hard parts; orientation and axes; ontogeny; and evolutionary history (Middle Cambrian-Holocene). The foregoing topics are exemplified by many taxa of living bivalves and, where pertinent, by fossil forms. Also included are a glossary of morphological terms applied to the bivalve shell and soft parts affecting it, and a selected list of names formerly applied to suprageneric taxa but not used in the Treatise classification. — VMJ

09446 **Cox, L. R.; Newell, N. D.; LaRocque, Aurèle.** Systematic descriptions [subclass Cryptodonta Neumayr, 1884], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N241-N248, illus., 1969.

In Cryptodonta, two orders are grouped provisionally: Solemyoida (Devonian-Holocene), comprising a single family including the extant *Solemya;* Praecardioida (Ordovician-Mississippian), a poorly understood, probably heterogeneous group comprising one superfamily, with the families Praecardiidae, Antipleuridae, and Butovicellidae; 20 genera and 5 subgenera are described. Cryptodonta are generally equivalve, thin-shelled, dimyarian; hinge plate absent or narrow, hinge margin

edentulous or taxodont; ligament external. The living *Solemya* is a siphonate, burrowing protobranch, morphologically different from the nuculoids, with oblong shell elongate anteriorly, gaping, edentulous. The praecardioids have circular to elongate shells, with interior features poorly defined or unknown in many forms; their role as ancestral burrowers is conjectural. — VMJ

Cox, L. R. *See* Newell, N. D. 09447

Cox, L. R. *See* LaRocque, Aurèle. 09448

Cox, L. R. *See* Newell, N. D. 09451

09496 **Cox, L. R.; Newell, N. D.** (and others). Systematic descriptions, *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1-2: New York, Geol. Soc. America (and Univ. Kansas Press), p. N225-N907, illus., 1969.

Taxonomy of the class Bivalvia Linné, 1758 (Middle Cambrian-Holocene) is treated to the generic level; 1,921 genera and 987 subgenera in addition to nominotypes are described (excluding suborder Ostreina, to be described in V. 3). These are assigned to 53 superfamilies, 14 orders, and six subclasses; subclass divisions Palaeotaxodonta, Cryptodonta, Pteriomorpha, Palaeoheterodonta, Heterodonta, Anomalodesmata, and the order Conocardioida (subclass uncertain) are cited separately under the authors of first appearance — A. L. McAlester, L. R. Cox, N. D. Newell, A. LaRocque, A. Chavan, N. D. Newell, and C. C. Branson, respectively. There are alphabetical lists of 192 additional bivalve genera uncertainly assigned to families, and 100 genera of doubtful affinities or unidentified. A 38-page reference list concludes the section. — VMJ

Cox, L. R. *See* Chavan, André. 09497

09500 **Cox, L. R.; Newell, N. D.** (and others). Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1-2: New York, Geol. Soc. America (and Univ. Kansas Press), V. 1, p. N1-N489, illus., tables, 1969; V. 2, p. N491-N951, illus., tables, 1969.

Volumes 1 and 2 of Pt. N include sections on: general features of the molluscan class Bivalvia (Pelecypoda); form, functions, and evolution, in which the concepts and methodology of interpretive paleontology are applied to bivalves; classification of Bivalvia; systematic descriptions to the generic level, including detailed treatment of morphology, ecology, and evolution of the geologically more important groups; and an addendum on notation of heterodont hinge teeth. The sections, and subdivisions of the systematic descriptions (six subclasses and one order of uncertain subclass), are cited separately in this bibliography, under authors of first appearance: L. R. Cox, E. G. Kauffmann, N. D. Newell, A. L. McAlester, A. LaRocque, A. Chavan, C. C. Branson, D. W. Boyd. Page N952 of the index, omitted here, is in Jour. Paleontology, v. 44, no. 2, p. 402, 1970. — VMJ

09511 **Craig, J. E. G., Jr.** Characteristics of use of geology literature: College and Research Libraries, v. 30, no. 3, p. 230-236, tables, 1969.

A citation analysis was made of a selection of the geology literature to determine the characteristics of literature use in current geologic research. More than three-fourths of the citations examined were to serial literature, more than 87 percent were to literature in the English language, more than one-third were to publications that had appeared during the previous five years, and 46 titles included half of the journal articles cited. Only 59 percent of the references were to journals classed by LC in geology; the balance fell in other disciplines. — *from* Author's abstract

09224 **Craig, J. R.; Kullerud, G.** Phase relations in the Cu-Fe-Ni-S system and their application to magmatic ore deposits, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 344-358, illus., tables, 1969.

A new view of the paragenesis of Ni-Cu ores is presented on the basis of experimental studies on the Cu-Fe-Ni-S system at liquidus temperatures to below 550°C. Results

indicate that "observed mineral assemblages may be explained in terms of phase changes occurring in a system of isochemical bulk composition in response to decreasing temperature." — VSN

02156 **Crickmay, C. H.** Ramparts, Beavertail, and other Devonian formations: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 67-79, illus., 1970.

The Ramparts Formation and associated deposits in the Northwest Territories, Canada, have long been a source of disagreement. Stratigraphic work by E. M. Kindle and many others is reviewed to date so as to bring out the opposed views that have prevailed. Eight stratigraphic sections are described from field work and core examination by the writer. The facts from these sections are marshalled to show the clear separation of Beavertail from Ramparts Formation, and the equivalence of Kee Scarp to Beavertail Formation. — Author's abstract

09597 **Crosby, Percy.** Petrogenetic and statistical implications of modal studies in Adirondack anorthosite, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 289-303, illus., tables, 1968 [1969].

Anorthositic rocks from the northeastern Adirondacks have been analyzed modally in thin sections and by special screen point counts on the outcrop. The thin section means approximate the average matrix composition of the larger sample areas, excluding plagioclase megacrysts. Individual recalculated modes and means, plotted after simplifying assumptions were made within the diopside-albite-anorthosite system, are compared with other anorthosites and proposed parent magmas. Tie lines between matrix compositions and coexisting plagioclase megacryst phases for early and late stages of crystallization suggest partial fusion of basaltic rocks as a possible mechanism for formation of the Adirondack anorthosites. — *from* Author's abstract

Cross, Ralph H., 3d. *See* Partheniades, Emmanuel. 09376

09513 **Crowl, G. H.** Surficial geology, Mount Stewart-Souris, Prince Edward Island: Canada Geol. Survey Map 1260A, scale 1:126,720, 1969.

This map accompanies Geol. Survey Canada Paper 67-66 (Crowl), 1969.

09613 **Crowl, G. H.** Geology of Mount Stewart-Souris map-area, Prince Edward Island: Canada Geol. Survey Paper 67-66, 26 p., illus., tables, geol. map, 1969.

The Mount Stewart-Souris area comprises the northern half of Prince Edward Island east of Charlottetown. Permian bedrock forms a homocline dipping uniformly northeast. The cuestiform topography is partly masked by Wisconsin deposits. Thin sand-till covers the upland. Anastomosing glaciofluvial deposits occupy the valleys and connect with one another through cols in the divides. The till was deposited over most of eastern Prince Edward Island by an ice advance from New Brunswick. This ice-sheet stagnated and down-melted in place; a later ice advance from the Cobequid Mountains of Nova Scotia covered a narrow strip along the south shore of the island. — Authors abstract

Cruft, Edgar F. *See* Husler, John W. 09301

09367 **Cruft, Edgar F.; Husler, John.** Direct reading emission spectrometric determination of trace metals in calcium sulfate minerals by organic enrichment: Anal. Chemistry, v. 41, no. 1, p. 175-177, tables, 1969.

Cd and Lu, fused in a sodium *m*-phosphate buffer and mixed with the solid enriched sample prior to analysis, were used as internal standards. Precipitation is carried out at a pH of 5.9 and Al is used as the collector. — AC brief

Cunningham, Richard R. *See* Hinds, Jim S. 02038

Currie, R. L. *See* Morrison, G. H. 09622

Curtin, Gary C. *See* Shacklette, Hansford T. 01876

09271 **Dahl, A. Orville.** Wall structure and composition of pollen and spores, [Chap.] 3 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 35-48, illus., 1969.

Applications of specialized microscopic techniques to analysis of spore and pollen structure are reviewed. Illustrations are scanning electron micrographs of intact pollen grains, electron micrographs of ultra thin sections and of carbon replica of the surface, and phase contrast photomicrographs of thin sections. Most pollen grains may be classified as being without differentiated pores or furrows (inaperturate) or with preformed openings or thin areas (aperturate); there is tremendous variation in number, size, distribution, and structure of apertures. Development of the sporoderm (complex cell wall) is traced, and a tabular summary is given of terminology of the layers of the mature sporoderm. — VMJ

09322 **Danbom, Steve H.** Crustal P wave travel times: Compass, v. 46, no. 2, p. 90-98, illus., tables, 1969.

Crustal P-wave traveltime curves are calculated for a three-layer crustal model. The upper layer has a linear velocity increase from the surface to five kilometers depth. The middle layer has a linear velocity decrease to a depth of nine kilometers. The bottom layer has a linear velocity increase to include the remaining part of the crust. A shadow zone is observed that is dependent upon the layer parameters. — Author's abstract

09150 **Darrah, William C.** A critical review of the Upper Pennsylvanian floras of eastern United States with notes on the Mazon Creek flora of Illinois: [Gettysburg, Pa.] privately printed, 220 p., illus., tables, 1969.

Present knowledge of the Upper Pennsylvanian floras of eastern and midcontinent U.S. and stratigraphic correlations with western Europe are reviewed. Floras of the Allegheny, Conemaugh, Monongahela, and Dunkard (Washington and Greene) Series of the Appalachian region, and their equivalents in midcontinent and elsewhere, are listed. About 37 selected genera (1 new) and over 100 species (7 new) of pteridophytes and gymnosperms are described or discussed, and figured on 80 plates. Floras of eastern U.S. show a clearly defined succession of zones, with index species of *Neuropteris*, *Alethopteris*, *Pecopteris*, *Sphenopteris*, *Mariopteris*, and other genera. *Callipteris*, index of Permian age, occurs first in the Greene Series (upper Dunkard). The Mazon Creek and Pittsburgh coal floras are cited as standards for Allegheny and Monongahela floras, respectively. — VMJ

09133 **Davar, K. S.** The analogous behavior of snowmelt and groundwater, *in* Groundwater-streamflow systems — Canadian Natl. Comm. Hydrol. Decade and Laval Univ., Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, p. 16-18, table, discussion [1969?].

The synthesis of streamflow hydrographs during winter and spring snowmelt requires an understanding of the snowmelt runoff process. A brief account has been presented of this phenomenon and present quantitative techniques summarized. Some similarities between snowmelt runoff and ground-water phenomena and some rather important dissimilarities have been pointed out. Extension of data collection and research into many aspects of snowmelt runoff and hydrograph synthesis appear necessary for improving the present status of this subject. — *from* Author's conclusion

Davidson, A. *See* Heywood, W. W. 09155

Davidson, A. *See* Heywood, W. W. 09252

09596 **Davis, Brian T. C.** Anorthositic and quartz syenitic series of the St. Regis quadrangle, New York, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 281-287, illus., 1968 [1969].

The St. Regis quadrangle is underlain largely by rocks of the anorthosite series. The outer and upper part of the anorthosite mass has a metamorphic foliation which along the borders dips outward beneath a sheet of overlying differentiated quartz

syenite gneiss. Anorthosite with less than 10 percent mafic minerals by volume forms the major member of the anorthosite series. The composition of the plagioclase (calcic andesine) has the same range throughout most facies of the anorthosite. The quartz syenite series has the general composition of a quartz syenite of charnockitic character but ranges from a mafic syenite in the basal portion to a granitic facies at the top. The quartz syenite sheet is intrusive into the rocks of the anorthosite series. — *from* Author's abstract

Davis, D. A. *See* Stevenson, D. R. 09136

Davis, L. L. *See* Weetman, Bruce G. 01998

Davis, L. L. *See* Williams, Spencer L. 02001

09253 **Davis, Ronald B.; Brewster, Lynn A.; Sutherland, Joyce.** Variation in pollen spectra within lakes [with French abs.]: Pollen et Spores, v. 11, no. 3, p. 557-571, tables, 1969.

Ten surface sediment samples were taken from random locations in each of six lakes in Florence County, northeastern Wisconsin, and chi-square homogeneity tests were run on pollen sample counts for each lake. The literature and the present study indicate that statistically significant differences in the proportions of pollen types occur in surface sediments from different water depths in the same lake; in very large lakes, differences may be extreme. Probable operative factors include: differences in flotation and sedimentation rates of different pollen types; irregular erosion of shallow-water sediments; and relatively uniform redeposition in the quieter deeper waters. — VMJ

02104 **Dawes, Peter R.** Grönlandske granater som smykkesten [Greenlands garnets as ornaments (with English abs.)]: Grönland 1970, no. 4, p. 113-119, illus., 1970.

A locality near Ravns Storö in West Greenland, particularly rich in well-shaped garnet crystals, was discovered in 1968. The garnet-bearing rocks are Precambrian metamorphic volcanic lavas and associated sediments at least 2,500 m.y. old. All garnets collected or seen are rhombdo decahedra and the vast majority are euhedral; crystals vary from a few mm to several cm across, the largest collected about 11 cm across. Color varies from brownish red to purplish red and mulberry color and crystals which have been polished by the sea have a deep purplish red color. Although the garnets are not translucent and are therefore not of high-class gem quality of immediate cash value, their use locally as a material for a modest craft, ornament and jewelry industry is considered worthy of consideration. — *from* Author's abstract

Dechaseaux, Colette. *See* Chavan, André. 09497

01905 **Decker, Robert W.; Harlow, David.** Microearthquakes at Cascade volcanoes [abs.]: EOS, v. 51, no. 4, p. 351, 1970.

09430 **Defretin-Lefranc, Simone.** Les conchostraces triasiques du Groenland oriental [with French abs.], [Chap.] 3 *in* Notes on Triassic stratigraphy and paleontology of north-eastern Jameson Land (East Greenland): Medd. Grönland, v. 168, no. 2, p. 123-142, illus., 1969.

Amongst the samples collected in eastern Greenland during Doctor Koch's expeditions, several species of Conchostraca were observed. These were: *Euestheria forbesii* (Jones), *Euestheria minuta* (von Zieten), *Euestheria emmonsi* (Raymond), *Pseudoasmussia grasmücki* nov. sp., *Cornia trumpyi* nov. sp. A pelecypod, which was formerly classed as a Conchostraca, *Halobia* cf. *moussoni* Merian, was also observed. This paleontological study gives a Triassic age to the formations in question. — Author's abstract

09558 **Delany, F.; Smith, C. H.** (editors). Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposi-

um, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 359-610, illus., tables, 1969.

The papers in this symposium were scheduled for presentation during the 23d International Geological Congress at Prague, Czechoslovakia. Because of the unexpected interruption to the Congress, only part of the papers were actually delivered. Hence certain papers are given here only in abstract form. Twenty-four papers, 10 of which are abstracts only, are cited separately. — VSN

09336 **Delevoryas, T.** Paleobotany, phylogeny, and a natural system of classification: Taxon, v. 18, no. 2, p. 204-212, 1969.

Examples of recent paleobotanical studies are presented to show the important role of the fossil-plant record in demonstrating origins and relationships of various plant groups. Work on Precambrian bacteria, algae, and fungi has recently assumed great importance in the study of plant beginnings. New finds of Devonian land plants present a clearer picture of early evolution of vascular plants. Discovery of the extinct progymnosperms such as *Archaeopteris* has supplied new evidence on origin of gymnosperms. There is important new knowledge of evolution of the seed habit. The extinct pteridosperms (Mississippian-Jurassic) are important in understanding origin of the cycadophytes and, possibly, of the flowering plants. Increasing understanding of phylogenetic events, by way of the fossil record, is indispensable for developing a natural system of plant classification. — VMJ

Delgado-Rodriguez, M. *See* Guardiola-Saenz, J. L. 09385

02009 **Demarest, Harold H., Jr.; Anderson, Orson L.** Phase changes and their effect on shear and P-wave velocities [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

Demarest, Harry. *See* Anderson, Orson L. 02011

09530 **Den Tex, E.** Origin of ultramafic rocks, their tectonic setting and history — A contribution to the discussion of the paper "The origin of ultramafic and ultrabasic rocks" by P. J. Wyllie, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 457-488, illus., 1969.

A subdivision of orogenic peridotites into ophiolitic (truly alpine-type) and "root-zone" peridotites is proposed, and their differences in tectonic setting and metamorphic facies are discussed. It is shown how various microstructural approaches, such as interpretive petrotectonic studies and comparative petrofabric analysis of peridotites and country rocks can be used to unravel the igneous, metamorphic, and tectonic histories of ultramafics. Brief summaries are presented of the fabric and metamorphic data for three types of peridotite: a "root-zone" and an ophiolitic peridotite, and some lherzolitic nodules from alkali-olivine basalts; their fabric and metamorphic histories are compared and contrasted. It is concluded that solid derivation from upper mantle material is the most likely origin for the three types and their impoverishment in eclogitic or basaltic constituents by partial fusion is improbable. — *from* Author's abstract

01902 **Dence, M. R.; vonEngelhardt, W.; Walter, L. S.; Plant, A. G.** Spheroids in impact glass from Clearwater Lake crater, Quebec [abs.]: EOS, v. 51, no. 4, p. 342, 1970.

Dennis, L. S. *See* Vogt, Peter R. 01993

02135 **Deuser, W. G.** Extreme $^{13}C/^{12}C$ variations in Quaternary dolomites from the continental shelf: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 118-124, tables, 1970.

Dolomite samples from submarine canyons off northeastern United States have δC-13 values ranging from -64 to +21 per mille relative to the PBD standard. δO-18 values were closely grouped at $+5.8 \pm 0.7$ per mille, however, and were higher than those of separately occurring aragonites of the same area. Extreme variations in the δC-13 content are most likely a consequence of differences in the extent and

pathways of utilization of limited organic-carbon reservoirs during formation of the carbonates. Dolomitization of the clastic precursor sediment apparently took place at a time of lowered sea level when evaporation in shallow lagoons on the upper shelf produced waters having high Mg and O-18 concentrations. — *from* Author's abstract

01888 **Deutsch, Ernst R.; Rao, Kunduri V.** Paleomagnetism of Ordovician sedimentary rocks from Bell Island, Newfoundland [abs.]: EOS, v. 51, no. 4, p. 272, 1970.

Deutsch, Sarah. *See* Boudin, Andre. 02120

09576 **deWaard, Dirk.** Annotated bibliography of anorthosite petrogenesis, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 1-11, illus., 1968 [1969].

This bibliography is comprised largely of papers in which ideas as to the genesis of anorthosite are expressed. An exception is made for early descriptions of anorthosite minerals, rocks, and regions. In the annotations the authors' basic ideas are summarized. — JWC

09599 **deWaard, Dirk; Romey, William D.** Petrogenetic relationships in the anorthosite-charnockite series of Snowy Mountain dome, south central Adirondacks, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 307-315, illus., tabies, 1968 [1969].

Detailed mapping in the small anorthosite massif of Snowy Mountain dome has revealed structural relations that indicate a cogenetic, largely magmatic genesis of members of an anorthosite-charnockite series. Anorthosite forms the core of the dome. It is surrounded by a shell which consists of hypersthene-bearing rocks that grade upward and outward from norite through jotunite and mangerite to farsundite and charnockite. This gradation appears to be primary and associated genetically with the andesine crystal accumulate. Where cross-cutting relations are observed, the more silicic rock types always invade the more calcic types. The anorthosite thus appears to have been essentially solid when later members of the series were yet in a magmatic condition. — *from* Authors' abstract

09614 **deWaard, Dirk.** The anorthosite problem, the problem of the anorthosite-charnockite suite of rocks, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 71-91, illus., tables, 1968 [1969].

The anorthosite problem concerns explanation of the following phenomena common to most terranes: (1) Large masses of almost pure plagioclase are as a rule associated with a series of rocks ranging from norite to charnockite; these commonly grade into one another, and are spatially arranged in such a way that norite adjoins the anorthosite while charnockite forms the outward member of the suite. (2) Anorthosite is essentially an aggregate of plagioclase megacrysts which have interstices filled with rock of noritic composition. (3) The rare transgressive relationships in the series consistently demonstrate that the more calcic rock is invaded, and the more silicic is intrusive. (4) Textures and structures indicate magmatic conditions for all members of the series, except for the plagioclase megacrysts which are the oldest solids of the series. The choice of processes to explain these phenomena may be limited to differentiation from a primary magma forming an early plagioclase cumulate, or partial anatexis of certain sediments leaving a plagioclase residuum. — *from* Authors abstract

02141 **Dewey, John F.; Bird, John M.** Mountain belts and the new global tectonics: Jour. Geophys. Research, v. 75, no. 14, p. 2625-2647, illus., 1970.

Mountain belts are a consequence of plate evolution, developed by the deformation and metamorphism of sedimentary and volcanic assemblages of Atlantic-type continental margins. Earliest assemblages are volcanic rocks and coarse clastic sediments. As continental margins move away from the ridge, nonvolcanic continental shelf and rise assemblages accumulate. If a trench develops near or at the continental margin, a mountain belt (cordilleran type) grows by dominantly thermal

mechanisms. If the continental margin collides with an island arc or another continent, a collision-type mountain belt develops by dominantly mechanical processes. Collision-type belts do not have paired metamorphic belts; they are characterized by a single dominant direction of thrusting and synorogenic sediment transport, away from the site of the trench over the underthrust plate. Stratigraphic sequences of mountain belts (geosynclinal sequences) match those associated with present-day oceans, island arcs, and continental margins. — *from* Authors' abstract

09349 **Dickas, Albert B.; Tychsen, Paul C.** Sediments and geology of Bois Brule River, western Lake Superior, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 161-169, illus., 1969.

The average mean size distribution of the clastic load of this river in Douglas County, based on the phi scale is: granules, 10 percent; sand, 74 percent; silt, 13 percent; and clay, 3 percent. To determine provenance of the sand (whether bedrock or till), gravels were examined petrographically. The glacial cover is the prime source of the clastic material of the river load, concurring with the mapping program which shows that outwash sands and reworked drift predominate over much of the drainage area. A secondary source is outcropping Keweenawan (Cambrian?) sandstones. Earlier studies indicate the river load is deposited in Lake Superior out to a distance of 1/2-1 mile from the shoreline with the finer material found at the greater distance from the littoral zone. — *from* Authors' abstract

02205 **Dickinson, W. R.** Global tectonics: Science, v. 168, no. 3936, p. 1250-1259, 1970.

This is a report on a Penrose Conference of the Geological Society of America, convened 15-20 December 1969 at Pacific Grove, Calif., to discuss the meaning of the new global tectonics for magmatism, sedimentation, and metamorphism in orogenic belts. The development of global tectonic concepts from Wegner's continental drift hypothesis to the present plate tectonic model is outlined, and the fresh light shed on many specific features of orogenic belts by the new model is summarized. — DBV

01900 **Dodd, R. T.** Calc-aluminous insets in olivine of the Sharps (H-3) chondrite [abs.]: EOS, v. 51, no. 4, p. 341, 1970.

09394 **Doerner, D. P.** Lower Tertiary biostratigraphy of southwestern Santa Cruz Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 17-29, illus., tables, 1969.

The Pozo Formation is at the base of the Tertiary section, and is overlain successively by the Cañada, Jolla Vieja, and Cozy Dell formations. Numerous faunules and zonules are recognized; they are, from bottom to top: *Turritella-Ostrea* faunule, *Cibicides-Trochammina* zonule (the Pozo Formation), *Eponides* zonule, *Bulimina-Plectofrondicularia* zonule (the middle Cañada Formation), and the *Cibicides-Cassidulina* zonule (the upper part of the Cañada Formation). Environmental conditions are discussed and faunal lists are included. — HRC

Doerner, D. P. *See* Weaver, D. W. 09395

Doerner, D. P. *See* Weaver, D. W. 09397

Doerner, David P. *See* Weaver, Donald W. 09625

Donnelly, Thomas W. *See* Murphy, Andrew J. 01956

Dorman, LeRoy M. *See* Kosalos, James G. 01942

02113 **Dorr, John A., Jr.; Eschman, Donald F.** Geology of Michigan: Ann Arbor, Mich., Univ. Michigan Press, 476 p., illus., tables, 1970.

This comprehensive treatment of the geology of Michigan, aimed at the nonprofessional reader, identifies and describes the principal geologic features of the state, their origin and the history of their evolution. Certain geological principles are defined and illustrated by examples from the region. Scenic aspects of geological features are emphasized for the benefit of tourists and students. Chapter headings are as follows: Earth history and geologic time, general geologic setting of Michigan, Precambrian eras, the Paleozoic, the lost interval, the Pleistocene, the Great Lakes in Late Glacial and Postglacial times, water and wind, petroleum and natural gas, minerals, rocks, fossil invertebrates, vertebrates and plants. A 7-page bibliography and a subject index are appended. — EH

09170 **Dorr, John van N., 2d.** Manganese, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 211-225, illus., table, 1969.

Manganese deposits in the vicinity of the Artillery Mountains, known for many years and among the more important syngenetic deposits in the United States from the viewpoint of total contained manganese oxide, occur north of Aguila and south of Kingman; the primary manganese oxides occur in the Pliocene (?) Chapin Wash Formation. Epigenetic vein and replacement deposits, widely scattered throughout the state, occur as fissure fillings and irregular replacement bodies in a wide variety of rocks. Perhaps the most widespread, although not the most productive, type of deposits is interstitial fillings in breccia zones. Although the Artillery Mountains area is one of the major sources of easily treated manganiferous material in the United States, the grade is low in comparison with deposits mined elsewhere. The low grade, thick cover of overburden, and large outlay of capital needed for large-scale mining and processing make open-pit mining uneconomic. — MCM

02121 **Douglas, G.; McDougall, D. J.** Some preliminary observations on the relationship of moisture-activated thermoluminescence to specific surface: Modern Geology, v. 1, no. 2, p. 119-121, illus., table, 1970.

Some characteristics of nonradiation-induced thermoluminescence are described; among causes for the phenomenon are sample preparation and handling, physical-chemical changes during heating, and tectonic history of geological materials. It may be concluded that moisture-activated thermoluminescence can be the cause of significant variations in the low intensity thermoluminscence measurements which are required for radiation, dosimetry, archeological age dating, and some geologic applications. The technique provides a possible method for determination of the specific surface of small particles; it may also be found useful for investigation of adsorbed water layers. — MCM

Douglas, Richard F. *See* Robertson, David S. 09464

02196 **Dowling, Forrest L.** Magnetotelluric measurements across the Wisconsin arch: Jour. Geophys. Research, v. 75, no. 14, p. 2683-2698, illus., tables, 1970.

Magnetotelluric observations were made at five stations across the Wisconsin arch. Electrical resistivity models of the earth at each of the five sites were obtained by fitting the apparent resistivity values of one-dimensional models to the measured values. The preferred conductivity models show a layered crustal structure which agrees well with the crustal seismic profile at the four best sites. The most striking result is an order-of-magnitude increase in conductivity at about 12 km depth, which corresponds to an intracrustal velocity interface. Near the crust-mantle boundary an increase in resistivity, comparable to that of the upper crust, is observed. Indications of a conductivity increase at 70 km depth were obtained at two of the stations; one of the models tenuously suggests another steeper conductivity increase at a depth of 170 km. — *from* Author's abstract

Dowling, John J. *See* Blumentritt, Russel. 01892

09521 **Drake, C. L.; Kosminskaya, I. P.** The transition from continental to oceanic crust, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci.

Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 363-384, illus., discussion, 1969.

It is shown that classification of continental margins into Atlantic and Pacific types is too simple, and it is more appropriate to relate them to the manner of development. Characteristics of the deep structure of the transition zones have been determined from seismic refraction studies, and it is obvious that their development is related to deep-seated physico-chemical changes. There is sharp disagreement about the relative importance of horizontal and vertical movements in producing features that can be observed today. Evidence of large-scale subsidence is recorded in sediments of present and fossil continental margins, but compelling arguments for major horizontal movements can be raised on the basis of recent data from ocean basins. Resolution of this problem will depend upon better correlation of marine and terrestrial geologic and geophysical data and determination of age and method of formation of ocean basins. — *from* Authors' abstract

Dratler, Jay, Jr. *See* Block, Barry. 02130

09440 **Dreimanis, A.** Late-Pleistocene lakes in the Ontario and the Erie basins, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 170-180, illus., 1969.

A lake was in the Ontario basin during the Sangamon, and its level rose above the present lake toward the end of the interval; possibly a contemporaneous lake was in the Erie basin. In the Ontario basin, high-level lakes are known from the start of the Wisconsin, during the Port Talbot and Plum Point Interstadials, and several towards the end of the last ice age. The lake level was below the present one during the St. Pierre Interstadial and for some time after the opening of the St. Lawrence outlet. The number of lakes or phases is greater in the Erie basin than in the Ontario because two ice lobes were present with more fluctuations of the margins. Lower levels than now are known from the Port Talbot and Plum Point Interstadials, the Port Huron-Cary Interstadial, and the late-glacial. — *from* Author's abstract

09545 **Drewe, John G.** Design and construction in permafrost at the Clinton Mine [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 207, 1969.

09615 **Dreyer, Robert M.** Evaluation of lateritic bauxite and nickel deposits [abs.]: Econ. Geology, v. 64, no. 8, p. 937-938, 1969.

09303 **Driscoll, Egbert G.** Animal-sediment relationships of the Coldwater and Marshall Formations of Michigan, *in* Stratigraphy and palaeontology — Essays in honour of Dorothy Hill (K. S. W. Campbell, editor): Canberra, Australian Natl. Univ. Press, p. 337-352, illus., 1969.

The importance of sedimentary parameters in controlling distribution of benthic organisms in level-bottom communities is accepted by most ecologists and paleoecologists. In a partial review of the relations between distribution of clastic sediment and that of benthic organisms, papers by Purdy (1964) and Craig and Jones (1966) are of particular importance. In an attempt to apply their concepts to a paleoecologic interpretation of Mississippian formations of Michigan, the distribution of fossil groups in the Coldwater Shale and Marshall Sandstone is in close accord with what might be theoretically postulated. During Coldwater time, sediments in the Michigan basin supported a less varied group of animals with preservable hard parts in an environment suited to deposit of feeding species. The environment developed in Marshall time favored suspension feeders. — GDC

Drummond, A. D. *See* Kimura, E. T. 09480

09481 **Drummond, A. D.; Kimura, E. T.** Hydrothermal alteration at Endako — A comparison to experimental studies: Canadian Mining and Metall. Bull., v. 62, no. 687, p. 709-714, illus., table, 1969.

The significance of K-feldspar-bearing and sericite-bearing envelopes within the pervasively kaolinized rocks of the Endako molybdenite deposit may be explained in the light of experimental studies by J. J. Hemley of the system K_2O-Al_2O_3-SiO_2-H_2O. The relative vein sequence of hydrothermal alteration products is illustrated more distinctly at Endako Mines than in many of the porphyry copper deposits. Cross-cutting relations indicate a relative age sequence among the various silicate stages which is in agreement with a chemical control based on the activity ratio of K^+/H^+ in a nearly isothermal environment. — Authors' abstract

09484 **Dugas, Jean; Assad, R.; Marleau, R.** Metallogenic concepts in Gaspé: Canadian Mining and Metall. Bull., v. 62, no. 688, p. 846-853, illus., table, 1969.

A study of the geological features of known occurrences of mineralization in Gaspé is the basis for a classification. Nickel, chromite, asbestos and some copper are pre- or syn-Taconic, whereas the most important deposits are tied to granitic post-Taconic stocks. Most occurrences are clearly related to igneous rocks: nickel, chromium and asbestos to Ordovician serpentinite; copper to volcanic rocks of different ages; and copper, zinc, and lead to acidic intrusions with apparent zoning. Some lead-zinc deposits lying between the Grande Greve and York Lake formations are stratigraphically controlled. Some occurrences are tied to faults; e.g., the nickel-copper mineralization along the North Grand Pabos fault. Northerly-trending transverse structures appear to coincide with the Gaspé Copper, Mount McGerrigle (Tabletop) granite and Lemieux dome areas of mineralization. — Authors' abstract

01895 **Duncan, John R.; Kulm, L. D.** Vertical tectonic movements in the Blanco Fracture Zone [abs.]: EOS, v. 51, no. 4, p. 331, 1970.

Dunham, Don. *See* Haskell, E. E., Jr. 02112

Dutro, J. Thomas, Jr. *See* Armstrong, Augustus K. 02072

09242 **Dutton, C. E.** Geology and magnetic data for central Iron River area, Michigan: Michigan Geol. Survey Rept. Inv. 5, 17 p., illus., table, geol. maps, 1969.

The central Iron River area lies south and west of the city of Iron River and is underlain by folded and faulted rocks of Animikie age, which from oldest to youngest are Badwater Greenstone, Dunn Creek Slate, Riverton Iron-Formation, and Stambaugh Formation. The structures in this area are part of the complicated western apex of the Iron River-Crystal Falls synclinorium; the major structure is a complex syncline in the southern part of the area and contained most of the iron ore produced from the central Iron River area; other structures are folds and faults of northeast and southwest trend in the northern part and those of north and south trend in the eastern part. Stratigraphic and structural data and interpretations based on outcrops, ground magnetic survey, exploration drilling, and mine mapping are presented. — Author's abstract

Dyck, W. *See* Smith, A. Y. 09475

01885 **Dziewonski, Adam; Porath, Hartmut.** Sedimentary conductivity anomalies in the Great Plains Province [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

Eardley, A. J. *See* Shuey, R. T. 01977

09247 **Echávez Valverde, Joaquín.** Lineamientos metalogeneticos en Mexico [Metallogenetic lineations in Mexico (with English abs.)]: Geología y Metalurgia, v. 4, no. 29, p. 49-73, illus., 1969.

In looking at a map of the mineral deposits of Mexico it is possible to distinguish concentrations and lineations of ore bodies. Five metallogenetic belts can be identified. Three of them have a general NW-SE direction and are designated Western belt, Central belt and Eastern belt. The two other lines, which are oriented generally E-W, are Parras belt and Volcanic belt. The five lineations, or belts, are related to tectonic structures. The areas of intersection or of close proximity of the metallogenetic lines

are of paramount interest, as in those areas the flow of mineralized solutions coming from the mantle (or close to it) is concentrated, and therefore these areas are the most favorable for mineral prospecting. — *from* Author's English abstract

02134 **Edgington, David N.; Callender, Edward.** Minor element geochemistry of Lake Michigan ferromanganese nodules: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 97-100, illus., table, 1970.

The Th and U levels in Lake Michigan nodules are quite different from those of marine nodules. The Ra content of the lake nodules is substantially higher than that in marine nodules. The Ba content is abnormally high and the Ba element is evenly dispersed. The average As content in the lake nodules is twice as high as that of highly oxidized marine sediments. If all this arsenic is dissolved and released into Green Bay as a result of changing environmental conditions, the concentration in the water of Green Bay would be several times the maximum permissible level for drinking water. — HRC

09297 **Edmond, C. R.** Direct determination of fluoride in phosphate rock samples using the specific ion electrode: Anal. Chemistry, v. 41, no. 10, p. 1327-1328, table, 1969.

A citrate buffer is used to prevent interference from Al. Results for standard phosphate rock samples are in good agreement with those obtained by other methods. — AC brief

Edwards, L. N. *See* Bereskin, S. R. 09503

02019 **Ehmann, W. D.; Baedecker, P. A.; McKown, D. M.** Gold and iridium in meteorites and some selected rocks: Geochim. et Cosmochim. Acta, v. 34, no. 4, p. 493-507, illus., tables, 1970.

Au and Ir abundances have been determined in stony meteorites and various meteoritic and terrestrial materials. Compilation of available Au data yields the following group averages (in 10^{-9} g per g): Cl-140, C2-177, C3-184, Enstatite-322, H-group-228, L-group-162, LL-group-167. Some earlier Ir determinations via radiochemical separations may be subject to significant analytical error. Ir concentrations for the various chondrite groups as determined by the nondestructive coincidence technique of this work are (in units as above): Cl-490, C2-608, C3-645, Enstatite-618, L-group-453, LL-group-371. The significance of the meteorite data to the life history of these objects is discussed. — DBV

01908 **Einwich, Anna M.; Higgs, Robert H.; Lowry, H. Michael.** Magnetic anomalies in the "smooth zone", western North Atlantic [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

09588 **Emslie, Ronald F.** Crystallization and differentiation of the Michikamau intrusion, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 163-173, illus., table, 1968 [1969].

The Michikamau intrusion in west-central Labrador is an anorthositic pluton with maximum surface dimensions of 65 km by at least 40 km. The main rock units in order of their crystallization are: a border zone of olivine gabbro, which is fine-grained and interpreted as a chilled zone; a thick series of layered leucotroctolite; a considerable thickness of anorthosite that is gradational upward into leucogabbro and gabbro; and ferrous-rich rocks that form the end products of crystallization. Fractionation trends are described. — *from* Author's abstract

09244 **Engineering and Mining Journal.** Side-look radar moves in on exploration: Eng. and Mining Jour., v. 170, no. 6, p. 124-125, illus., 1969.

Side-looking radar, capable of imaging certain objects that aerial photography cannot register, uses a band of the electromagnetic spectrum previously used very little, can see through clouds, is independent of lighting, and produces a continuous strip map on which geologic structures stand out more clearly. Its major shortcoming, as with most noninfrared airphotos, is the inability to see through foliage. Some areas

with almost continuous cloud cover have been mapped by radar, for example, Darien Province, Panama. Long-standing assumptions of the geology of some areas may prove to be inadequate in the light of this new technique. — ESL

02024 **Ensminger, H. Robert.** Seismic profiling in the Gulf of Mexico: UnderSea Technology, v. 11, no. 2, p. 22-25, illus., tables, 1970.

A seismic section profiler provided the first clear, deeply penetrating sub-bottom picture of the deep gulf; the profiler is described. Profiles across three JOIDES corehole sites are included. — ESL

09183 **Ericksen, George E.** Brucite and magnesite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 320-324, illus., table, 1969.

The deposits in the Oatman district are the only ones in Arizona that contain potentially commercial amounts of brucite; however, the grade proved too low for economic shipment and continued operation. Chemical analysis of the brucite-bearing material indicates the deposits contain considerable amounts of calcite and dolomite, or magnesite, in addition to brucite. — MCM

Ernst, W. G. *See* Papike, J. J. 09403

Ernst, W. G. *See* Onuki, Hitoshi. 09420

Eschman, Donald F. *See* Dorr, John A., Jr. 02113

09234 **Espenshade, G. H.** Kyanite and related minerals, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 382-385, table, 1969.

In Arizona all the kyanite-group minerals occur mostly in areas of Precambrian rocks. Two deposits of size and quality required to have economic value have been explored — the one near Quartzsite, Yuma County, and the kyanite deposit on Squaw Peak, Maricopa County. — WLG

Essene, Eric J. *See* Bancroft, G. Michael. 09407

Estes, Richard. *See* Welles, S. P. 09153

09490 **Estes, Richard.** The Batrachosauroididae and Scapherpetontidae, Late Cretaceous and early Cenozoic salamanders: Copeia 1969, no. 2, p. 225-234, illus., 1969.

The genera *Batrachosauroides* and *Opisthotriton* comprise the extinct salamander family Batrachosauroididae (Late Cretaceous through middle Miocene). *Batrachosauroides gotoi*, n.sp. is a new early Eocene record of the type genus. On the basis of the centrum shape and unusually high, narrow, keeled neural spines the family is probably related to *Scapherpeton*, *Lisserpeton*, and *Piceoerpeton*. The latter is removed from the Cryptobranchidae and placed with two former genera in the extinct family Scapherpetontidae (Late Cretaceous through early Eocene). Both families are entirely North American, so far as presently known, and are here referred to the suborder Ambystomatoidea. — Author's abstract

09616 **Estes, Richard.** Studies on fossil phyllodont fishes — Interrelationships and evolution in the Phyllodontidae (Albuloidei): Copeia 1969, no. 2, p. 317-331, illus., 1969.

Fishes possessing multiple, superposed (phyllodont) sets of replacement teeth occur in at least seven teleost families. The fossil genera *Phyllodus*, *Egertonia*, *Paralbula*, *Pseudoegertonia*, and probably *Eodiaphyodus* are grouped as an extinct family Phyllodontidae of the order Elopiformes. The first two genera form the Phyllodontinae; the other three are placed in the Paralbulinae, n.subfam. All described records of the family are discussed and reinterpreted. *Phyllodus toliapicus* is newly recorded from the early Paleocene of Montana, and *Paralbula casei*, n.sp., is described from the Late

Cretaceous of New Jersey and Alberta, and the early Eocene of England. These are the first midcontinental North American occurrences of the Phyllodontidae, as well as the earliest geological occurrences of the family. The range of *Paralbula* is extended to England and Africa. — Authors abstract

02137 **Eugster, O.; Tera, F.; Burnett, D. S.; Wasserburg, G. J.** Isotopic composition of gadolinium and neutron-capture effects in some meteorites: Jour. Geophys. Research, v. 75, no. 14, p. 2753-2768, illus., tables, 1970.

The isotopic composition of Gd in one chondrite, two achondrites, and the silicate inclusions of two iron meteorites has been determined. When corrected for mass discrimination, Gd in all but one sample shows the same relative isotopic abundances as terrestrial Gd. These results set an upper limit of 3×10^{15} neutrons per cm^2 on a differential integrated thermal neutron irradiation of the Earth and these meteorites. Neutron-capture effects are present in Gd extracted from the Norton County achondrite, most probably produced by secondary neutrons during the exceptionally long cosmic ray exposure. The isotopic anomalies correspond to an integrated thermal neutron flux of $(6.3 \pm 0.9) \times 10^{15}$ neutrons per cm^2. The percent abundances of terrestrial Gd isotopes are given. Because of the higher precision, these abundances should replace the currently accepted values. — *from* Authors' abstract

09284 **Evitt, William R.** Dinoflagellates and other organisms in palynological preparations, [Chap.] 18 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 439-479, illus., 1969.

Palynological preparations often contain, besides land-plant palynomorphs, microfossils of varied or uncertain affinities representing aquatic, apparently unicellular organisms. Their study constitutes a rapidly growing field of micropaleontology. Literature reviewed concerns chiefly dinoflagellates (Permian-Holocene), acritarchs (Precambrian-Tertiary), and chitinozoans (Cambrian-Devonian). Morphology, classification, stratigraphic distribution, and significance are discussed for each group. Studies of living dinoflagellates (classed as pyrrhophytic algae) demonstrate that probably all fossil forms represent resting cysts, and that many hystrichospheres are dinoflagellate cysts. Acritarchs are a miscellaneous grouping of organisms of uncertain affinities; some may be dinoflagellates. Chitinozoa were probably not mobile organisms and may even be metazoan egg cases. — VMJ

09549 **Ewing, Maurice.** (and others). Initial reports of the Deep Sea Drilling Project — V. 1 covering Leg 1 of cruises of Drilling Vessel *Glomar Challenger*, Orange, Tex., to Hoboken, N. J., Aug.-Sept. 1968: Washington, D. C., U.S. Govt. Printing Office, 672 p., illus., tables [1969,].

In May 1964, the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) was formed. The successful drilling effort in the summer of 1965, on the Blake Plateau, led to an 18-month drilling program in the Atlantic and Pacific Oceans, termed the Deep Sea Drilling Project; operations began in Aug. 1968. Cores recovered will furnish reference material for future studies, and a report, describing core material, and information obtained is to be published after completion of each cruise. The present report comprises 26 papers, of which 20 are cited separately. The first seven are site reports; part 2 contains 16 papers on shore laboratories studies; and part 3 is a cruise leg synthesis. Two appendices cover time stratigraphic framework and a sample list. — ESL

09248 **Fabregat Guinchard, Francisco José.** Los datos del análisis químico como criterio de identificación mineralógica [Chemical analysis data as a criterion for mineral identification]: Geología y Metaluria, v. 4, no. 29, p. 29-46, tables, 1969.

Following a brief statement on the role of chemical analysis in the identification of minerals, and using sulfur as an example, all the known sulfur minerals and their chemical analyses according to Dana's system are listed. — EH

Fairbairn, H. W. *See* Heath, Stanley A. 09584

09537 **Fairbridge, Rhodes W.** Polar migration, sea-floor spreading, atolls and climate change [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 545-546, 1969.

Farquhar, Roger P. *See* Lange, Arthur L. 09245

09350 **Farrand, William R.** The Quaternary history of Lake Superior, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 181-197, illus., tables, 1969.

The Quaternary history of Lake Superior basin is largely restricted to the late Pleistocene except possibly for the submerged valleys in the east which resemble a fluvial system modified by glaciation. The Quaternary sedimentary cover of the lake bottom represents the waning phases of the Wisconsin glaciation. Red till at the base grades upward through red and then gray varves into gray and brown postglacial clays which are over 1000 feet thick in the west. The late-glacial lacustrine episode is present in shorelines 500 feet above the present level at Duluth and 750 feet on Isle Royale. The earliest lake stages drained into the Mississippi system and later shifted to the east via various routes. An extremely low stage occurred about 10,000 years ago and the lake level has been rising since in response to glacial rebound. — *from* Author's abstract

Farrar, Yvonne J. *See* Florence, T. M. 09300

Fellows, Martha. *See* Hodgson, J. F. 09381

02209 **Fertl, Walter H.; Timko, Donald J.** Distinction of oil and gas in clean and shaly sands as derived from well logs, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. I1-I20, illus., table, 1970.

Well logs assist in the distinction of oil and gas in clean and shaly pay sands, and, under favorable conditions, allow a computed approximation of the hydrocarbon densities. However, estimation of the hydrocarbon densities, especially in very shaly formations, become questionable without reliable "shaliness" values and knowledge of the residual hydrocarbon saturation. Properly selected logging programs also assist in the detection of gas/oil or hydrocarbon/water contacts in open and cased holes. Computational techniques and several qualitative methods can be applied. The latter include crossplot techniques and various overlays of comparable scaled porosity or resistivity logs. We particularly recommend these techniques when the interpretation of sidewall samples becomes questionable, such as in shallow pay sands in the Gulf Coast area. Several field examples illustrate the application of the methods. — Authors' abstract

02210 **Fertl, Walter H.; Timko, Donald J.** Association of salinity variations and geopressures in soft and hard rock, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. J1-J23, illus., tables, 1970.

In situ and surface measurements of salinity variations in formations penetrated by the drill can be conducted. Experience in soft and hard rocks indicates changes in salinity are related to environmental conditions and tectonic features. Of importance is evidence that such salinity variations appear related to occurrence of overpressured formations (geopressures). However, such correlation may be limited by the fact that formation salinities can vary quite markedly with rock stresses due to tectonics such as faulting, salt dome uplift, unconformities, and other local or regional geology. In addition, salinity variations combined with other conventional logging parameters help pinpoint formations which exhibit severe borehole stability problems. Field case examples from the Gulf Coast area and Oklahoma are presented which illustrate the application of the salinity concept to engineering and geologic problems. — *from* Authors' abstract

Fillo, Paul V. *See* Tooker, E. W. 02030

09410 **Finger, Larry W.** The crystal structure and cation distribution of a grunerite, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 95-100, illus., tables, 1969.

Three-dimensional, counter-measured, X-ray diffraction data have been used in the refinement of the anisotropic atomic parameters and cation distribution of a grunerite from the Wabush iron formation, Labrador, Canada. The occupancies of the cation sites were determined by assuming the chemical composition of $(Fe_{6.2}Mg_{0.8})Si_8O_{22}OH)_{1.5}F_{0.5}$ and constraining the occupancies so that each of the four independent sites was full of Fe + Mg and the overall chemistry matched the formula. The resulting occupancies for Mg are as follows: M(1), 0.152 ± 0.008; M(2), 0.227 ± 0.007; M(3), 0.112 ± 0.012; and M(4), 0.015 ±0.008. These occupancies are in agreement with the previous determinations for this mineral. — Author's abstract

01909 **Fink, L. Kenneth, Jr.** Evidence for the antiquity of the Lesser Antilles Island Arc [abs.]: EOS, v. 51, no. 4, p. 326-327, 1970.

01882 **Fischbuch, N. R.** *Amphipora* and *Euryamphipora* (Stromatoporoidea) from the Devonian of western Canada: Palaeontology, v. 13, pt. 1, p. 64-75, illus., 1970.

Amphipora and *Euryamphipora* from the Devonian Swan Hills Formation of central Alberta are described and illustrated. Three varieties of *Amphipora* are recognized and are referred to *A. augusta*, *A. pervesiculata*, and *A. ramosa*; a new species of *Euryamphipora* (*E. mollis*) and the type species *E. platyformis* are also present. *Amphipora* is placed in the Clathrodictyidae with *Euryamphipora* since they have identical tissue. "Juvenile" forms, which may represent an early astogenetic stage, are found associated with mature *Amphipora* coenostea. The concept that some forms of *Amphipora* grew without producing a peripheral rim is rejected, and the absence of this feature is considered the result of abrasion. — *from* Author's abstract

01877 **Fischer, R. P.; Ohl, Jane P.** Bibliography on the geology and resources of vanadium: U.S. Geol. Survey Bull. 1316, 168 p., 1970.

This bibliography, which contains nearly 1,400 references and 3,000 index entries, covers literature published through 1967. It was compiled to aid studies on the geology and resources of vanadium; it is worldwide in scope. Most references are to original sources of information on the distribution and occurrence of vanadium-bearing deposits, on the geochemical relations of vanadium in rocks and deposits, and on vanadium mineralogy; some references on the exploitation and metallurgical treatment of vanadium source materials are included. A list of vanadium minerals and their chemical formulas is also included. — RPF

09179 **Fischer, R. P.** Vanadium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 293-296, illus., 1969.

In Arizona more than 90 percent of vanadium output has come from vanadium-uranium deposits in sandstone in the northeastern part of the State, mainly in the Jurassic Morrison Formation in the Carrizo Mountains and the Chilchinbito areas, and in the Triassic Chinle Formation in the Monument Valley area. The only other known kind of deposit is the vanadate type consisting of lead, zinc, or copper vanadates that occur in the oxidized zones of veins containing base metals. Only three deposits have been productive: Mammoth-St. Anthony mine, Mammoth district, Pinal County; Defiance mine, Globe district, Gila County; and C and B property, Dripping Springs district, Pinal County. — WLG

02124 **Fisher, David E.** Search for ^3He in deep-sea basalts: Earth and Planetary Sci. Letters, v. 8, no. 1, p. 77-78, table, 1970.

Certain deep-sea basalts contain excess He-4 and Ar-40 with He-4/Ar-40 ratios up to 15, indicating a rare gas component present in the magma before eruption, and trapped in the rock. Since the He-4/Ar-40 values are about maximum expected from Th, U, K decay in a closed system with terrestrial Th, U, and K values, it appears that these rocks have not lost significant amounts of He-4 by post-eruption diffusion. If

there is an He-3 source in deep regions sampled by these magmas, then certain amounts of He-3 should also be trapped. Six samples are analyzed for He-3. The amount is significantly less than the predicted primordial abundance if the original rocks were gas-rich and chondritic, as has been suggested. If these were the original types, then they have been degassed since formation, and since the residence time of He-3 in the atmosphere is about 10^6 yr, then the primordial helium is no longer with us on the Earth. — HRC

Fleming, C. A. *See* Chavan, André 09497

01910 **Flint, Jean-Jacques.** Topologic relation between length and number of streams [abs.]: EOS, v. 51, no. 4, p. 278, 1970.

09300 **Florence, T. M.; Johnson, D. A.; Farrar, Yvonne J.** Spectrophotometric determination of uranium(VI) with 2-(2-pyridylazo)-5-diethylaminophenol: Anal. Chemistry, v. 41, no. 12, p. 1652-1654, illus., tables, 1969

The complex formed has a molar absorptivity of 7.61×10^4 at 564 nm in 40 percent acetone and pH 8.2. The PADAP method is also highly selective towards U(VI). — AC brief

02218 **Foord, Eugene E.; Parrott, William R.; Ritter, Dale F.** Definition of possible stratigraphic units in north central Long Island, New York, based on detailed examination of selected well cores: Jour. Sed. Petrology, v. 40, no. 1, p. 194-204, illus., table, 1970.

Unconsolidated sediments from two deep wells in north central Long Island, N.Y. were examined and analyzed with respect to clay mineral, heavy mineral, and textural parameters. Utilizing the data obtained, five stratigraphic units are postulated for this area. Differences in clay mineral assemblages provided the most definite means of establishing unit boundaries. These differences are generally accompanied by definite textural changes and heavy mineral assemblage variations. The lowest unit is probably Late Cretaceous in age, with the upper three units being most likely late Pleistocene in age. The remaining unit is stratigraphically complex, and its age may be either Tertiary or early Pleistocene, or both. Whether these units have any regional significance awaits further similar work with drill core samples in the region. — *from* Authors' abstract

Foote, R. Q. *See* Weetman, Bruce G. 01998

Foote, R. Q. *See* Williams, Spencer L. 02001

01911 **Foote, Richard Q.; Loux, P. C.; Hays, W. W.** Analysis of ground motions, Rulison event [abs.]: EOS, v. 51, no. 4, p. 345, 1970.

Forbes, Robert B. *See* Gedney, Larry. 02140

09617 **Fortier, Y. O.** (chairman). National Advisory Committee on Research in the Geological Sciences, 19th annual report, 1968-1969 — Annual review and reports of subcommittees: Canada Geol. Survey Paper 69-6, 56 p., 1969.

In addition to a general survey of work done in 1968-69, the paper includes reports of the following subcommittees: structural geology; stratigraphy, paleontology and sedimentology; storage and retrieval of geological data (includes appendixes on working committees and proposal for Canadian Geoscience Data Institute); Quaternary geology; mineralogy, geochemistry and petrology; mineral deposits; and geophysical methods applied to geological problems. An appendix lists research grants awarded for 1969-70. — MCM

Foster, Benjamin. *See* Kapp, Ronald O. 09353

02032 **Foster, Helen L.** Reconnaissance geologic map of the Tanacross quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I-593, scale 1:250,000, text, 1970.

Unconsolidated deposits in the Tanacross quadrangle are fluvial, colluvial, eolian, and glacial. Sedimentary rocks of Late Cretaceous(?) and Tertiary age occur in small patches in widely separated areas of both the Yukon-Tanana Upland and the Alaska Range; they were subaerially deposited and probably have been extensively eroded as only small remnants remain. Metamorphic rocks range from greenschist to amphibolite facies, igneous rocks from silicic to mafic and ultramafic, and from fine grained to coarsely porphyritic. Straight parallel ridges and stream valleys suggest a NE-striking structural control; several ENE-striking faults are mapped and many others are suspected. No significant mineral deposits have been discovered; a body of magnesite marble has been quarried to a limited extent; and gravel has been used extensively for local roads. — MCM

09509 **Fox, Richard C.** Studies of Late Cretaceous vertebrates — [Pt.] 3, A triconodont mammal from Alberta: Canadian Jour. Zoology, v. 47, no. 6, p. 1253-1256, illus., table, 1969.

Alticonodon lindoei, new gen. and sp., a triconodont mammal from the early Campanian Upper Milk River Formation, Alberta, is the first known triconodont of Late Cretaceous age, and only the second recorded from post-Jurassic rocks. Progressive specializations in *Alticonodon* suggest a more highly developed shearing of the postcanine dentition than in geologically older members of the order. — Author's abstract

02028 **Foxworthy, Bruce L.** Hydrologic conditions and artificial recharge through a well in the Salem Heights area of Salem, Oregon: U.S. Geol. Survey Water-Supply Paper 1594-F, p. F1-F56, illus., tables, geol. map, 1970.

In the Salem Heights area of Salem, pumping from wells that tap a permeable zone of limited extent in basalt of the Columbia River Group caused serious year-to-year declines of ground-water levels. As a result of a series of injection tests, the specific capacity of the well was reduced temporarily, but there were no apparent deleterious effects on quality of the ground water. Pressure rise from the injected water spread rapidly through the permeable aquifer, but residual buildup of ground-water levels was soon masked by a seasonal rising trend of levels. Geologic and hydrologic conditions preclude escape of substantial volumes of the recharge water from the area. Conditions appear favorable for further artificial recharge of the main aquifers. Changes in specific capacity of the recharge well provide guidance for subsurface injection. — *from* Author's abstract

Francheteau, Jean. *See* Sclater, John G. 01975

02197 **Francheteau, Jean; Sclater, J. G.; Menard, H. W.** Pattern of relative motion from fracture zone and spreading rate data in the north-eastern Pacific: Nature, v. 226, no. 5247, p. 746-748, illus., table, 1970.

Analysis of fracture zone and spreading rate data in the northeastern Pacific suggests that (1) even where the ocean floor has been extensively mapped, knowledge of fracture zone trends is not adequate to reliably locate a pole of relative motion; (2) the generalization that present poles of relative motion tend to cluster around the geographic pole does not seem to be true for the past motion of the northeast Pacific and Farallon plates; (3) large original offsets of the ridge crests (long transform faults) might stabilize the motion of the two plates; (4) any major change in the spreading pattern must be global; and (5) changes in the relative motion of the northeast Pacific and Farallon plates have been very frequent (every 10 to 20 m.y.). The fracture zone and spreading rate data are consistent and indicate that rigid plate tectonics may be a valid model to use in reconstructing the past positions of continents. — DBV

02098 **Frankel, Larry.** A technique for investigating microorganism associations: Jour. Paleontology, v. 44, no. 3, p. 575-577, illus., 1970.

The microfauna of estuarine and marine sandy sediments can be fixed, stained and then infiltrated by Epon 812 without significantly altering the *in situ* distribution of sediment grains and organisms. Thin sections made from the polymerized material provide a new means of studying microorganism associations. — Author's abstract

09254 **Fredskild, Bent.** A postglacial standard pollen diagram from Peary Land, North Greenland [with French abs.]: Pollen et Spores, v. 11, no. 3, p. 573-583, illus., 1969.

Percentage and absolute pollen diagrams and an uplift curve for C-14 dates are constructed from analysis of sediment cores from lake Klaresö — about 1 m of clayey chalk gyttja, and about 30 cm of the underlying marine clay. The percentage diagram is divided into three zones: herb, *Salix arctica*, and decreasing *Salix* and increasing herbs. History of the lake is interpreted: After retreat of the Jörgen Brönlund Fjord glacier, lake Klaresö was isolated, about 5,000 yr ago. Later, the fjords became open in summer and, during a climatic optimum about 4,000 to 3,300 yr ago, *Salix arctica* became widespread and paleo-eskimos lived on the raised beaches. When the polar basin and fjords became permanently frozen, about 2,500 yr ago, the vegetation gradually changed to the present high-arctic desert flora. — VMJ

02092 **Frey, Robert W.** Environmental significance of Recent marine lebensspuren near Beaufort, North Carolina: Jour. Paleontology, v. 44, no. 3, p. 507-519, illus., tables, 1970.

Tracks, trails, burrows and living tubes of marine organisms living in beach, tidal flat, shoal, and salt-marsh environments near Beaufort, N.C., are described and illustrated. A checklist of trace-making organisms gives their distribution and abundance in different environments; the animals studied include anemones, a nemertean, polychaetes, gastropods, pelecypods, a merostomate, decapods, ophiuroids, echinoids, holothurians, and an enteropneust. Only gastropod and arthropod trails are similar to well-known fossil lebensspuren, and similar traces are made by different taxa. Burrows are most likely to be preserved and the abundance, type of burrows and amount of bioturbation has environmental significance regardless of which organisms produced them. — JWH

01883 **Fricker, P. E.; Goldstein, J. I.; Summers, A. L.** Cooling rates and thermal histories of iron and stony-iron meteorites: Geochim. et Cosmochim. Acta, v. 34, no. 4, p. 475-491, illus., tables, 1970.

Cooling rates of meteorite parent bodies calculated on basis of theoretical thermal models are compared with those derived by diffusion-growth analysis of the metal phase of iron and stony-iron meteorites. Previous calculations are extended to include effects of melting, redistribution of radioactive heat sources, and surface heating. For a range of assumed conditions, cooling rates depend strongly on extent of internal redistribution of radioactive elements. Calculations are not consistent with development of iron meteorites by surface heating of parent bodies. The core model appears to be appropriate for some irons; however, variable cooling rates for groups IIIa and IVa are explained by a model having small iron bodies distributed throughout the parent body from deep interior out to a fractional radius of 0.90 to 0.95. Such a distribution could be produced by zonal melting. — DBV

01912 **Fujisawa, Hideyuki.** Elastic properties of polycrystalline olivine [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

02183 **Fuller, Michael; Lowrie, W.** Comments on paper by P. N. Shive, "The effect of internal stress on the thermoremanence of nickel" [1969]: Jour. Geophys. Research, v. 75, no. 14, p. 2781-2783, illus., 1970.

The paper under discussion (ibid., v. 74, no. 15, p. 3781-3788, 1969) was cited in *Abstracts of North American Geology* for February 1970.— DBV

09339 **Funkhouser, John W.** Factors that affect sample reliability, [Chap.] 6 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 97-102, 1969.

Causes of unreliability in palynological samples are enumerated; ways of recognizing and possibly avoiding them are discussed. Hand-collected samples, including almost all surface samples, are most commonly contaminated by modern pollen and spores; weathering may destroy fossils in soft sediments. The commonest mechanically collected samples are from oil-well drilling: conventional cores give the most reliable

samples, cuttings the least. Contamination comes from many sources, in all stages of sample collection and preparation: air (modern pollen, fossil pollen in coal mines); shipping, due to careless packing of samples; water supply; laboratory equipment; caving, drilling mud, and recirculation material in well drilling. Reworking of fossils, and its opposite, stratigraphic leakage, can present problems if the fossils differ only slightly in age. — VMJ

Gair, J. E. *See* Pettijohn, F. J. 09343

02089 **Galton, Peter M.** The posture of hadrosaurian dinosaurs: Jour. Paleontology, v. 44, no. 3, p. 464-473, illus., tables, 1970.

Comparisons of hadrosaurs with undoubtedly quadrupedal dinosaurs and graviportal mammals show that hadrosaurs were bipedal. Arguments used to show that hadrosaurs were quadrupedal indicate only that most of the thoracic and caudal sections of the vertebral column were held more or less horizontally as in many birds. — Author's abstract

09437 **Gamer, Robert L.** The book of ten thousand pages: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 9, p. 72-75, 78, illus., 1969.

During the week-long President's Camp-out at Ochoco Summit near Mitchell, Oreg., members of the Geological Society of Oregon Country studied the history of the area from the Permian to the present. Permian beds are metamorphosed and separated from the Cretaceous by an angular unconformity which is 9,000 feet thick, and consists of two interfingering, highly folded formations; an angular unconformity separates these from the Eocene. Tertiary rocks all laid down on uplands, consist of four formations containing much volcanic material and the Columbia River Basalt. Repeated uplift and subsidence caused interfingering and unconformities. Fossils found are listed. — ESL

02174 **Gardner, J.** Geomorphic significance of avalanches in the Lake Louise area, Alberta, Canada: Arctic and Alpine Research, v. 2, no. 2, p. 135-144, illus., tables, 1970.

Snow avalanches and their geomorphic effects were studied in the Lake Louise area of the Canadian Rocky Mountains. Data on avalanche frequency for the late spring through summer period and for diurnal periods are given. Avalanches occur throughout the area, but the presence of distinctive geomorphic features above tree line suggests that they are most effective as geomorphic agents in areas devoid of vegetation. Avalanches carry rock material of assorted sizes on a variety of debris slopes including avalanche boulder tongues of the fan and roadbank types. In addition to the form and sedimentology of these features, the presence of debris tails on their surfaces also indicates avalanche activity. — *from* Author's abstract

09290 **Garman, R. Keith.** Geologic map of the Monterey Lake quadrangle, Tennessee: Tennessee Div. Geology Geol. Map GM 331-SE, scale 1:24,000, separate text, 1969.

Mined mineral resources of the Monterey Lake quadrangle are: sand for construction purposes from the Sewanee Conglomerate; limestone for most uses from the St. Louis, Monteagle, and Bangor Limestones; and coal in limited amounts from the Wilder seam. Potential resources are dimension sandstone and shale. — MCM

Gasparini, Paolo. *See* Civetta, Lucia. 09296

09473 **Gaucher, Edwin; Saint Amant, Marcel.** Evaluation of EM anomalies at Soquem [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 211, 1969.

Gaymard, R. *See* Poupon, A. 02208

09154 **Gaynanov, A. G.; Isayev, Ye. N.; Stroyev, P. A.; Ushakov, S. A.** Izostaziya Beringova morya [Isostasy of Bering Sea (with English abs.)]: Akad. Nauk SSSR Mezhdunedomstv. Geofiz. Kom. Geofiz. Byull., no. 20, p. 15-19, illus., 1969.

The topographic-isostatic corrections are described and the isostatic anomalies for Bering Sea are analyzed. It is established that the Commander Islands and southeastern part of the Aleutian trench are under-compensated. The isostatic anomalies follow the continuation of the coastal structures to the foot of the continental slope. The greatest deviation from isostasy is observed in the Aleutian arc, an area of present stresses in the crust and mantle, reflected in the high seismicity of this region. Positive isostatic anomalies characterize the marginal oceanic rise. — DBV

02140 **Gedney, Larry; Matteson, Charles; Forbes, Robert B.** Seismic refraction profiles of the ash flow in the Valley of Ten Thousand Smokes, Katmai National Monument, Alaska: Jour. Geophys. Research, v. 75, no. 14, p. 2619-2624, illus., 1970.

Two seismic profiles across the 1912 pyroclastic flow in the south and central branches of the Valley of Ten Thousand Smokes give P-wave velocities within the flow of 0.38-0.92 kmps, indicating considerable lateral variation in compaction and (or) welding. Average P-wave velocities of 2.8 kmps were obtained for the underlying strata. The bedrock underlying the south branch of the valley is displaced by a normal fault at the east end of the profile. A fissure fumarole line overlies this fault on the surface of the ash flow, indicating a deep rather than 'rootless' origin for these particular fumaroles. Maximum thicknesses of 50 and 25 m were determined for the pyroclastic flow in the south and central branches of the valley, respectively, in approximate agreement with depths found from gravity and refraction surveys, but in strong disagreement with the estimated thickness up to 300 m suggested by some workers. — *from* Authors' abstract

01913 **Gemperle, Michael; Couch, Richard W.** Geophysical investigations of the continental margin off southeast Alaska [abs.]: EOS, v. 51, no. 4, p. 316, 1970.

09423 **Gendzwill, Robert G.** Crystal structure of synthesized zinc sulfides: Compass, v. 46, no. 2, p. 118-121, illus., 1969.

Attempts to synthesize zinc sulfides of varying iron content by heating in aqueous solutions of zinc and iron sulfates, resulted in the precipitation of mixtures of sphalerite and wurtzite, as verified by X-ray diffraction. The iron content of powdered zinc sulfides can be accurately determined by reflectance spectrophotometry of long visible wave-lengths. Synthetic sphalerite-wurtzite mixtures containing from 0 percent to 12 percent Fe by weight are easily identified and the iron content determined by their reflectivity at wave lengths of 6000 to 7000 Angstroms. — Author's abstract

Gerard, J. T. *See* Morrison, G. H. 09622

09406 **Ghose, Subrata; Schindler, Peter.** Determination of the distribution of trace amounts of Mn^{2+} in diopsides by electron paramagnetic resonance, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 51-58, illus., tables, 1969.

Three types of Mn^{2+} distribution have been found in natural diopside: most in the Ca-site, most in the Mg-site, and all in the Mg-site. Natural and synthetic diopsides known to have crystallized above 900°C and containing less than 0.001 percent Mn invariably show all Mn^{2+} in the Mg-site. — *from* Authors' abstract

09411 **Gibbs, G. V.** Crystal structure of protoamphibole, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 101-109, illus., tables, 1969.

The structure for protoamphibole has been verified and refined by three-dimensional Fourier and least-squares methods using data collected with a Weissenberg single crystal counter-diffractometer. The structure consists of layers of interlocking chains of fluorine-centered hexagonal rings of SiO_4 groups. The layers are bound together by Mg, Li cations which are coordinated between the chains, the coordination being effected by a stagger between adjacent layers. The individual Si-O bond distances in the chains are given. — *from* Author's abstract

02074 **Gill, Dan.** Application of a statistical zonation method to reservoir evaluation and digitized-log analysis: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 719-729, illus., 1970.

For geologic data recorded in drill holes and columnar sections, plotting a measured attribute involves location along a vertical line; and for profile data (topographic, structural, geophysical, etc.), plotting involves location along a horizontal line. Hypothetically, plotting volumes of similar data would produce a three-dimensional picture, and an "electric log" analogy wherein zones are bounded by, or include major and minor inflection points. Zonation of such data provides features such as lithologic units, biozones, geographic regions, etc., and detection of major boundaries locates distinct events such as formation tops, seismic reflections, etc. In the statistical zonation method, variances within zones can be minimized and variances between zones can be maximized, permitting detection of otherwise obscure boundaries.

09542 **Girard, Paul.** Geology of the Madeleine Mines deposit: Canadian Mining and Metall. Bull., v. 62, no. 688, p. 837-845, illus., 1969.

The copper property is in Lapotardière and Boisbuisson townships, Gaspé North. The initial find was made in 1964, and subsequently a copper deposit of 5.3 million tons of ore was outlined. The property lies in Ordovician sedimentary and volcanic rocks near the McGerrigle Range granite intrusive. The host-rock is a 300-ft-thick metamorphosed silty shale, close to the contact of the intrusive. The structure consists of a southerly-dipping monocline or the south limb of an anticline, on which a large dragfold has been imposed. Chalcopyrite, bornite, and chalcocite are the principal sulfides present; their zoning arrangement is of particular interest. The orebody appears to be a fracture-filling deposit genetically related to the granite intrusive and is confined within a highly fractured zone of very brittle rock. The deposit presents features uncommon to other copper deposits in the Gaspé Peninsula. — *from* Author's abstract

02213 **Glanville, C. R.** Log interpretation of thinly-bedded, oil-productive sands with unusually low resistivities, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. M1-M27, illus., tables, 1970.

Certain Miocene pay sands in the Louisiana Gulf Coast, including thinly-bedded, silty to shaly, exhibit low resistivities and may not be identified as potentially oil-productive by standard log interpretation procedures. A careful, detailed study of logs and conventional cores from a Miocene reservoir showed the relatively clean, permeable layers produce oil; they have relatively low water saturations and relatively high resistivities. A practical log interpretation technique for these sands requires only two logs, an induction-electrical log and a density log with a gamma ray curve; charts and tables provide reliable detections of potentially oil-productive sands and good estimates of porosities and water saturations. The technique is apt to be applicable to many thinly-bedded reservoir sands, but further experience is needed to determine the general utility of the present correlations. — *from* Author's abstract

09610 **Glaser, John D.** Petrology and origin of Potomac and Magothy (Cretaceous) sediments, middle Atlantic Coastal Plain: Maryland Geol. Survey Rept. Inv. 11, 102 p., illus., tables, 1969.

These basal clastics, a southeasterly-expanding wedge in the Chesapeake-Delaware Embayment, grade from fluvial into marine facies — a depositional model, in basin geometry, sediment fill, dispersal pattern, and tectonic setting. Their thickness variations, crossbedding, pebble counts, textural analyses, and petrography, especially heavy minerals, give clues to provenance and depositional environments that differ from previous interpretations. In the Potomac Group, the Patuxent Formation, filling braided river channels, had two Piedmont sources — a southern granitic area, and a northern, mostly high-grade schist; the Arundel Clay, restricted to Maryland, has thick lignitic lenses, and was floodbasin deposited; the Patapsco and Raritan Formations, from weathered Piedmont terrain and Appalachian sandstones, were deposited

on floodplains across the northern basin flank. The overlying Magothy Formation, a widespread thin schist-derived sheet, grades into estuarine-marginal deltaic facies. — GDC

09548 **Gleeson, Christopher F.; Martin, L.** Application of reconnaissance geochemistry in Gaspé: Canadian Mining and Metall. Bull., v. 62., no. 688, p. 819-823, illus., 1969.

Geochemical stream-sediment reconnaissance can be a useful exploration tool, especially in rugged mountainous areas. Such surveys have been carried out for the past two years in the Appalachians of northern New Brunswick and Gaspé, covering about 4,000 sq mi. Metallic mineralization has been found which otherwise might not have been detected. Electronic computation of the information has been used to construct regional-metal and rolling-mean maps, and residual-metal maps, which have helped in evaluating anomalies, in relating regional geochemistry to regional geology, and in comparing distribution patterns. Some 30,000 stream-sediment samples have been collected from the Gaspé area and analyzed for Cu, Pb, Zn, and Mn. The analyses are being subjected to computer analysis. — *from* Authors' abstract

01914 **Goetze, Christopher.** Measurements of attenuation of polycrystalline salts at high temperatures [abs.]: EOS, v. 51, no. 4, p. 417, 1970.

Goldberg, Donald T. *See* Borbereky, Horst. 09515

01915 **Goldstein, Alan S.; Henyey, Thomas L.** Studies of secular variation from late Cenozoic sediments, Lake Tahoe, California-Nevada [abs.]: EOS, v. 51, no. 4, p. 270, 1970.

Goldstein, J. I. *See* Fricker, P. E. 01883

02175 **Goldthwait, Richard P.** Mountain glaciers of the Presidential Range in New Hampshire: Arctic and Alpine Research, v. 2, no. 2, p. 85-102, illus., tables, 1970.

Nine steep-walled cirques nearly 1,000 feet deep and U-shaped valleys > 1/2 mile wide were formed at one time in the White Mountains, and at least three other incipient basins were ice-deepened. These were fully formed before an overriding continental glaciation took place in late-Wisconsin stage as based upon the nearest C-14 deglaciation dates, shallow alpine soils, weathering of mountaintop erratics, and freshness of valley deposits. The sharpness of the cirque rims indicates mountain glacier action no older than early Wisconsin time, and the volume of removal suggests Illinoian-stage cutting as well. Forms eroded in rock show that former local glaciers were possibly 1 to 8 miles long with a firn limit near 3,000 to 4,000-foot altitude. The lowest cirques face north and the highest ones south, indicating insolation sensitivity and fair skies during the mountain glacier ablation season. — *from* Author's abstract

02022 **Good, Charles W.; Taylor, Thomas N.** On the structure of *Cordaites felicis* Benson from the Lower Pennsylvanian of North America: Palaeontology, v. 13, pt. 1, p. 29-39, illus., 1970.

New material of *Cordaites felicis* Benson is described from Lower Pennsylvanian petrifactions collected in eastern Kentucky. Additional information about the anatomy and epidermal pattern is provided and an emended diagnosis is presented together with a discussion of other structurally preserved cordaitean leaves. — Authors' abstract

Good, John M. *See* Love, J. D. 02083

Gornitz, Vivian. *See* Bender, Michael. 01893

Gough, D. I. *See* Camfield, P. A. 02065

Gough, D. I. *See* Porath, Hartmut. 02067

Graham, A. R. *See* Kilburn, L. C. 09222

Graham, A. R. *See* Wilson, H. D. B. 09264

Grant, Richard E. *See* Cooper, G. Arthur. 02100

09377 **Grasmück, K.; Trümpy, R.** Triassic stratigraphy and general geology of the country around Fleming Fjord (East Greenland), [Chap.] 1 *in* Notes on Triassic stratigraphy and paleontology of north-eastern Jameson Land (East Greenland): Medd. Grönland, v. 168, no. 2, p. 5-74, illus., geol. map, 1969.

The lowermost Triassic formation (Wordie Creek Fm.) can be subdivided biostratigraphically into several ammonite zones. The two higher formations consist of poorly fossiliferous redbeds; the Mt. Nordenskiold Formation is understood to comprise the newly defined Paradigma Member (arkose) and Solfaldsdal Member (red mudstones, shales with gypsum), the Cape Biot Fm., the Cape Seaforth Member (variegated shales with gypsum), the Fleming Fjord Member (massive red mudstones) and the Örsted Dal Member (shales and sandstones). Detritus was mainly derived from the east. The complex fault pattern of Wegener Halvö is described; a large NW-heading normal fault runs along Fleming Fjord. Broad anticlines and narrower synclines to the NE of it are probably subordinate to this fault. — *from* Authors' abstract

09526 **Green, D. H.** The origin of basaltic and nephelinitic magmas in the Earth's mantle, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 409-422, illus., 1969.

Over the past ten years, the availability of solid-media high pressure apparatus capable of generating pressures up to 50 kbar at closely controlled temperatures (to 1,700°C) has led to a rapid acceleration of direct experimental studies of both simple systems and natural rocks under high pressure conditions. These studies have been most fruitful in elucidating possible genetic relationships among basalts and it is now possible to erect a rather complete and self-consistent model in which a peridotitic mantle, by processes of partial melting, magma segregation and further magma fractionation, may produce liquids ranging in composition from olivine melilite nephelinite to olivine tholeiite. — Author's summary

09578 **Green, Trevor H.** Experimental fractional crystallization of quartz diorite and its application to the problem of anorthosite origin, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 23-29, illus., tables, 1968 [1969].

Experimental fractional crystallization of a quartz diorite composition in the 0-13.5 range shows that plagioclase is the liquidus phase over this pressure range and is the major crystallizing phase. It is joined by pyroxene and opaque minerals at lower temperatures. There is a marked increase in albite content of the liquidus and near-liquidus plagioclase with increasing pressure. The crystalline portion of the quartz diorite at 50 percent crystallization is approximately the same as gabbroic anorthosite, and the liquid fraction is granitic. Anorthosite may represent a separate from a parental quartz diorite magma, or it may represent residual, unmelted material following anatectic extraction of more silicic material deep in the crust. — *from* Author's abstract

09555 **Greene, Gordon W.; Moxham, Robert M.; Harvey, Arnold H.** Aerial infrared surveys and borehole temperature measurements of coal mine fires in Pennsylvania, *in* Symposium on remote sensing of environment, 6th Internat., Ann Arbor, Mich., 1969, Proc., V. 1: Ann Arbor, Mich., Univ. Michigan, Willow Run Labs., p. 517-525, illus., 1969.

Aerial infrared surveys were made in 1966 and 1967 over 22 coal mine fires in Pennsylvania. Fires at shallow depths (< 10 m) were easily detected. Fires at intermediate depths (10-30 m) were detected when heat was carried to the surface by convection in open cracks, or if the fire had been burning long enough (several years, or more) to permit heat to reach the surface by conduction. Fires at depths > 30 m were detected only when heat reached the surface by convection in open cracks;

conducted heat from these requires a decade, or more, to be detected at the surface. The surveys defined limits of shallow fire areas and revealed fires in several new areas. Interpretation of geothermal profiles in boreholes at one site showed that temperatures within the mine quickly rose to 7°C when the ventilation system was shut down about 10 years previously, and that the mine fire reached the area near the borehole about a year before temperature measurements in 1966. — *from* Authors' abstract

01879 **Greene, H. Gary.** A portable refraction seismograph survey of gold placer areas near Nome, Alaska: U.S. Geol. Survey Bull. 1312-B, p. B1-B29, illus., 1970.

Beach survey results indicated: seismic velocities of 500-2,400 fps on Holocene sands; 2,000-3,400 on overburden layers especially near river mouths; 4,000-6,000 on Sangamon silt, clay, and sand; and 9,200-13,200 on Illinoian till. Bedrock was well defined with velocities from 14,000-18,500 fps. A short experimental seismic line completed inland reduced basic problems in permafrost areas by setting off the seismic explosion on the surface and placing geophones in the thaw zone of silt. A basement contour map of the beach was constructed from depth data obtained by the refraction seismograph, offshore seismic-reflection data, and onshore drill-hole information. Several buried channels identified may be sites of possible gold placer deposits. A cross section shows the bedrock surface dips under Dry Creek from both sides; a bedrock contour map was drawn from refraction seismograph data and drill-hole information. Tundra survey results illustrate feasibility of the seismograph as a tool for placer prospecting. — *from* Author's abstract

Greenwood, William R. *See* Hedberg, Marion R. 02201

Griffin, Margaret S. *See* Weld, Betsy A. 02036

09341 **Griffin, William L.** Replacement antiperthites in gneisses of the Babbitt-Embarrass area, Minnesota, U.S.A.: Lithos, v. 2, no. 2, p. 171-186, illus., tables, 1969.

In zoned, antiperthitic plagioclase, abundant in amphibolite-facies gneisses of this area, concentrations of K-feldspar blebs within antiperthite grains are surrounded by haloes of plagioclase that is either more sodic or more calcic than the host grain. Microprobe analyses show that composition of the halo and host plagioclase varies from grain to grain within a single sample. K depletion in haloes is quantitatively insufficient to supply the K in antiperthitic K-feldspar blebs, suggesting origin by exsolution is improbable. Relations between zoning and antiperthitic K-feldspar are generally in accord with those predicted by Hofmann (1967) for alkali-infiltration metasomatism of plagioclase-bearing rocks. Presence of wide sodic or calcic haloes around K-feldspar blebs in antiperthites may probably be regarded as evidence of origin by replacement. — *from* Author's abstract

Griggs, G. *See* Weaver, D. W. 09398

Grijalva, V. E. *See* Brown, H. D. 02207

Grimaldi, F. S. *See* Schnepfe, M. M. 09342

02118 **Gross, D. L.; Lineback, J. A.; White, W. A.; Ayer, N. J.; Collinson, Charles; Leland, H. V.** Studies of Lake Michigan bottom sediments — No. 1, Preliminary stratigraphy of unconsolidated sediments from the southwestern part of Lake Michigan: Illinois Geol. Survey Environmental Geology Note 30, 20 p., illus., 1970.

Lacustrine sediments cored at 4-mi intervals along a line extending from 12-32 mi due east from Waukegan, Ill., illustrate a local stratigraphy for unconsolidated sediments that floor southwestern Lake Michigan. The sequence includes, from the top, a few cm of sandy silty clay on the lake floor; 0.5-1.0 m of dark gray silty clay alternating with thin black clay layers; 0.5 m of brownish gray silty clay containing thin dark layers; 0.75 m of orangish brown clay in which there is a traceable gray clay bed 0.15 m thick; and a homogeneous, pink clay more than 1.0 m thick that overlies glacial outwash and till. Black layers in the upper part of the cores have yielded a

radiocarbon date of 6290 ± 200 yr B.P. Within the sediments, grain size decreases with depth; water content ranges from 100 percent to more than 200 percent of dry weight. Illite, chlorite, kaolinite, and expandable clay minerals are mixed throughout; expandables decrease downward and kaolinite decreases upward. — *from* Authors' abstract

09385 **Guardiola-Saenz, J. L.; Delgado-Rodriguez, M.** An accessory plate for the microscopic observation of soils: Soil Sci., v. 108, no. 6, p. 445-447, illus., 1969.

The results obtained with this new accessory plate were compared with those using the gypsum plate. The red color produced by gypsum is very similar to the red color in some soils. As a result, the definition using a gypsum plate is much poorer than using the second-order blue accessory plate. — JWH

Guest, J. E. *See* Murray, J. B. 02202

01917 **Guja, N. H.; Vincenz, S. A.** Paleomagnetic investigations of Jamaica [abs.]: EOS, v. 51, no. 4, p. 270, 1970.

01918 **Gumper, Frank J.; Scholz, C. H.** Microearthquake seismicity, Death Valley, California to Fairview Peak, Nevada [abs.]: EOS, v. 51, no. 4, p. 351-352, 1970.

Gumper, Frank J. *See* Sbar, Marc L. 01973

Gutschick, Raymond C. *See* McKee, Edwin D. 09557

Haas, Fritz. *See* LaRocque, Aurèle. 09448

02097 **Haas, Otto.** Recent literature on Mesozoic ammonites, Pt. 11: Jour. Paleontology, v. 44, no. 3, p. 544-557, 1970.

More than 80 publications, dated 1966 to 1969, are reviewed in the format of an annotated bibliography divided into General, Triassic, Jurassic, and Cretaceous sections. Proposed new taxa include one suborder, one family, one subfamily, 16 genera, 8 subgenera, and many species. — JWH

Hafner, Stefan S. *See* Virgo, David. 09408

09204 **Haigler, Leon B.** Geothermal resources, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 575-580, illus., table, 1969.

There are no criteria available at this time to indicate probable occurrences of geothermal steam in commercial quantities in Arizona, which explains in part, why no test holes have been drilled for geothermal energy. The only indications of possibly latent geothermal energy at depth are thermal springs and wells that show higher than normal thermal gradients. All reported springs with temperatures of 85°F or more and wells with a thermal gradient of 3°F or more per 100 feet of depth are listed in a table. — WLG

01920 **Hales, A. L.; Helsley, C. E.; Nation, J. B.** Travel times for an oceanic path [abs.]: EOS, v. 51, no. 4, p. 359, 1970.

09425 **Hales, Anton L.** K voprosu o promezhutochnykh sloyakh v zemnoy kore [On the problem of intermediate layers in the Earth's crust], *in* Internat. Conf. Experts on Explosion Seismology, 1st. Leningrad, 1968, Trans.: Kiev, U.S.S.R., Akad. Nauk Ukrain. SSR Inst. Geofiziki (Izdatel'stvo Naukova Dumka), p. 38-51, illus., table, 1969.

The difficulty in detecting waves from an intermediate layer is related to the fact that on continents they are rarely observed in first arrivals, and to use later arrivals in the usual way is not effective. A better way of utilizing later arrivals is to shorten distance between receiving stations or shots. To illustrate the efficiency of this procedure an

example is given of crustal structure for the Texas Gulf Coastal region: sedimentary formations (2.0 kmps) — 0.3 km; sediments and Cretaceous formations, mixed (5.5 kmps) — 4.8 km; basement (6.0 kmps) — 17.9 km; intermediate layer (7.3 kmps) — 4.0 km; mantle (8.65 kmps). There is evidence for a low velocity layer in the crust. For maximum use of information contained in surface waves, a promising procedure has been developed for determining phase velocities of Love and Rayleigh waves; its application to two profiles in Africa reveals two low velocity channels in the crust. — DBV

Haley, James F. *See* Borbereky, Horst. 09515

09338 **Hall, John W.** Notes on fossil Salviniaceae: Taxon, v. 18, no. 6, p. 735, 1969.

Azolla hamata and *A. sagittifera* Srivastava, 1968, Upper Cretaceous, Alberta, are considered synonyms of *A. circinata* Oltz and Hall, 1968 and *Azollopsis tomentosa* Hall, 1968, respectively, both Upper Cretaceous, Montana. *Azolla polyancyra* Stough, 1968 is referred to *Azollopsis* Hall, 1968. A lectotype is chosen for *Salvinia aureovallis* Jain and Hall, 1969, Eocene, North Dakota. The section *Kremastopora* Jain and Hall, 1969, erected for the genus *Azolla; A. teschiana*, type species for the section, is the same as for the subgenus *Florschuetzia* Kempf, 1968, but subgenera are not now in usage for this genus. — VMJ

Hamano, Y. *See* Mizutani, H. 02138

09487 **Hamilton, W. N.** Subsurface gypsum deposits near Fort McMurray, Alberta: Canadian Mining and Metall. Bull., v. 62, no. 691, p. 1193-1202, illus., tables, 1969.

As a result of a test-drilling program, a gypsum deposit averaging 30 feet in thickness, with a chemical purity of 84 percent gypsum, has been proven to underlie the Clearwater River valley for a distance of 18 miles at depths ranging from near-surface to 300 feet. This, and other subsurface deposits in the vicinity, are the product of local hydration of anhydrite beds believed to be the water-insoluble remains of the leached Prairie Evaporite formation of Middle Devonian age, the thick salt section of which is preserved down dip. The effects of salt solution are seen in the disturbed bedding and the intermixture of greyish green shale with gypsum in the core, the shale content being responsible for the rather low chemical purity of the deposit. A similar gypsum deposit, but probably of higher purity, is postulated to occur beneath the Athabasca River valley about 60 miles north of Fort McMurray. — *from* Author's abstract

02012 **Hammond, Douglas E.; Takahashi, Taro; Bassett, William A.** Isothermal compression of CsI up to 226 kilobars at 23°C [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

01921 **Hanks, T. C.; Brune, J. N.** Seismicity of the San Gorgonio Pass [abs.]: EOS, v. 51, no. 4, p. 352, 1970.

09210 **Harbour, Jerry.** Pollen profile of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 83-95, illus., 1969.

Over nine feet of sediment was channeled and sampled. *Artemisia* pollen dominates the entire profile, with *Quercus* and Gramineae also common; *Juniperus* is in minor amounts. All species are common in the prairie grassland of today, but the distribution is different. The lake pollen assemblage is common to that of the lower part of the pinyon-juniper and the upper part of the sagebrush zone of the northern desert shrubs in parts of the Rocky Mountain region. The climate of the Rita Blanca sediments cannot be categorized as pluvial or interpluvial, nor is a subtropical climate indicated. The abundance of *Artemisia* compared with the abundance of calcium carbonate implies the relative abundance of *Artemisia* was related to cooler summers. The outstanding feature of the pollen profile is its uniformity. — HRC

01922 **Hardy, H. Reginald, Jr.; Kimble, E. J.; Kim, R. Y.** Development of facilities for monitoring microseismic activity in geologic materials [abs.]: EOS, v. 51, no. 4, p. 350-351, 1970.

09601 **Hargraves, R. B.** A contribution to the geology of the Diana Syenite Gneiss Complex, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 343-356, illus., table, 1968 [1969].

Locally preserved relict textures and intrusive relationships indicate an igneous origin for the Diana Syenite Gneiss Complex. A prominent structural and topographic lineament approximately parallel to the foliation bisects the complex. One large anorthositic metagabbro mass and several smaller ones occur along the southeast side of the syenite gneiss. Petrographic and X-ray studies essentially confirm that the Diana Complex is an overturned, gravity-stratified sheet. — *from* Author's abstract

Harlow, David. *See* Decker, Robert W. 01905

09280 **Hart, George F.** Palynology of the Permian period, [Chap.] 13 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 271-289, illus., 1969.

The Permian land flora is distinct from those of the preceding and succeeding periods, owing to effects of the Gondwanian glacial epoch and to the definite separation into a northern Laurasian and a southern Gondwanian landmass. Distribution maps for Permian miospores show that the four provinces based on plant megafossils can also be delimited palynologically; between the northern and southern regions, major palynological taxa are almost completely different. In the Gondwanian province, the Permian can be divided into four florizones: the Camerati, Cingulati, Zonati (named for subturmae of zonal spores), and Striatiti (infraturma of disaccate pollen). Suggested phylogeny of saccate pollen taxa is diagrammed. Permian pollens differ from Carboniferous taxa much more than do spores. The Cathaysian province of Laurasia was apparently a refugium for a relict Carboniferous flora. — VMJ

01923 **Hart, Roger A.** Chemical exchange between sea water and deep ocean basalts [abs.]: EOS, v. 51, no. 4, p. 326, 1970.

Harvey, Arnold H. *See* Greene, Gordon W. 09555

02112 **Haskell, E. E., Jr.; Dunham, Don.** Geophysical exploration at small earthfill damsites: Jour. Soil and Water Conserv., v. 25, no. 2, p. 66-67, illus., 1970.

Major construction problems frequently encountered during excavation of spillways and core trenches at small earthfill dams in the Sierra Nevada foothills are deeper unconsolidated material than expected, a bedrock configuration too steep and blocky to excavate easily, and ground-water flow into the excavation. Depth of unconsolidated material is usually estimated by hand augering or backhoe digging at several points; the limited depth possible by these methods can be supplemented by the seismic refraction method, provided the density of the profile increases with depth. Seismic refraction should be used only to augment and extend direct profile observations at Sierra Nevada foothill sites; fewer backhoe pits and auger holes are needed if seismic interpretations closely correlate with profile observations. — MCM

Hasslacher, Robert N. *See* Sweeney, John W. 01881

09147 **Hatch, Norman L., Jr.** Geologic map of the Worthington quadrangle, Hampshire and Berkshire Counties, Massachusetts: U.S. Geol. Survey Geol. Quad. Map GQ-857, scale 1:24,000, section, text, 1969.

Small sills and dikes of pegmatite and granite which intrude the Goshen Formation are the youngest rocks in the Worthington quadrangle; rocks are inferred to be late tectonic and thus Early(?) or Middle(?) Devonian. Metasedimentary and metavolcanic rocks form steeply dipping, subparallel, north-trending bands and show an abundance of minor folds, cleavages, lineations interpreted as formed during four distinct stages of deformation. The relation between development of metamorphic minerals and various stages of folding is outlined. Possible mineral resources include sand and gravel, manganese, and talc. — MCM

Haugh, Bruce N. *See* Sutherland, Patrick K. 09363

09351 **Hawley, Eugene F.; Judge, Charles W.** Characteristics of Lake Michigan bottom profiles and sediments from Lakeside, Michigan to Gary, Indiana, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 198-209, illus., 1969.

About 500 sand samples and hydrographic profiles were studied to evaluate littoral processes on the southeast shore of Lake Michigan. One or two offshore bars are present and shift from year to year. Accretion is predominant in the region. The bottom sands are brownish, subrounded, and contain about 3-5 percent metamorphic minerals; some coarse sediments are 100 percent rock fragments. The sediment distribution trends follow the coastline and bathymetry and are stable from year to year. In general, medium sand predominates above waterline; the coarsest material occurs at the waterline. Offshore, medium and fine sands occur; fine sand is predominant. Littoral drift is toward the WSW. — HRC

02123 **Hayatsu, A.; Carmichael, C. M.** K-Ar isochron method and initial argon ratios: Earth and Planetary Sci. Letters, v. 8, no. 1, p. 71-76, illus., tables, 1970.

Ar-40/Ar-36 versus K-40/Ar-36 isochron plots of 3 sets of discordant K-Ar age data yielded concordant isochrons with different initial Ar-40/Ar-36 ratios. These results indicate that (1) the initial Ar-40/Ar-36 ratio was homogeneous within each set of samples but not always equal to the present atmospheric argon ratio, (2) the standard method of nonradiogenic argon correction is, therefore, not always adequate, (3) this isochron method can yield more meaningful ages, and (4) excess argon can be due to high initial Ar-40/Ar-36 ratio. — Authors' abstract

09157 **Hayes, Philip T.; Morrison, Roger B.** Geology and topography, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 35-58, illus., 1969.

This general outline of Arizona's geology and topography with a brief resume of economic mineral resources is intended to provide the background for the papers on mineral and water resources which follow. Beginning with the Precambrian, the general nature of the layered rocks is delineated. Cenozoic rocks contain most of the ground water, considerable amounts of construction materials, and other valuable mineral deposits. Rocks have been faulted and folded many times in the past; most activity took place during relatively short episodes and was often approximately concurrent with episodes of igneous activity. All major and most minor base and precious metal deposits are in the Basin and Range province and in the Tonto section of the Colorado Plateaus province where most intrusive rocks are located. The only known oil, gas, and helium, principal coal resources, most uranium, and potash are in the Navajo, Grand Canyon, and Flagstaff sections of the Colorado Plateau. — MCM

Hays, W. W. *See* Foote, Richard Q. 01911

Hays, W. W. *See* Weetman, Bruce G. 01998

Hays, W. W. *See* Williams, Spencer L. 02001

02080 **Hazel, Joseph E.** The Atlantic continental shelf and slope of the United States — Ostracode zoogeography in the southern Nova Scotian and northern Virginian faunal provinces: U.S. Geol. Survey Prof. Paper 529-E, p. E1-E21, illus., tables, 1970.

Ostracodes were identified from 236 bottom samples taken in the region from Nova Scotia to Long Island. There is a distinctive difference between the assemblages in the northern and southern parts of this region. Many sublittoral cryophilic species are not present south of Cape Cod or the Northeast Channel. Several thermophilic species are not found north of Cape Cod or Georges Bank. The ostracode assemblages of the southern part of the cold-temperate Nova Scotian province are a mixture of amphiatlantic cryophilic species and endemic, mainly thermophilic, species; European forms make up about 56 percent of the species. Less than 25 percent of the species known from the mild-temperate Virginian province have been reported from European waters. More endemic species pass Cape Cod from the south than amphiatlantic cryophilic species do from the north. — JEH

02215 **Healey, D. L.** Calculated in situ bulk densities from subsurface gravity observations and density logs, Nevada Test Site and Hot Creek Valley, Nye County, Nevada, *in* Geological Survey research 1970, Chap. B: U.S. Geol. Survey Prof. Paper 700-B, p. B52-B62, illus., table, 1970.

At the Nevada Test Site and Hot Creek Valley a borehole gravity meter was used to log four holes, and standard gravity meters were used to log five 48-inch-diameter holes and a vertical shaft. Three holes (Ue2y, test well B, and UCe-18) and the U5i shaft penetrated alluvium, and six holes penetrated Tertiary volcanic rocks on Pahute Mesa. The weighted average densities determined in the holes and shaft in alluvium are 1.94, 1.69, 2.22, and 2.05 g/cc, respectively; the density determined in five of the six holes in Tertiary volcanic rocks ranged from 1.98 to 2.06 g/cc, respectively. One hole (UE19n) penetrated a thick ash-flow tuff that averaged 1.51 g/cc. Density logs were taken in 10 additional holes. In Yucca Flat the mean density of more than 7,000 feet of alluvium is 2.01 g/cc, and in Hot Creek Valley the mean of more than 18,000 feet is 2.18 g/cc. — Author's abstract

09380 **Healy, J.** Rezul'taty seysmicheskikh issledovaniy Zemnoy kory i mantii v SShA i zadachi dal'neyshikh issledovaniy [Results of seismic investigations of the Earth's crust and mantle in the U.S.A. and tasks of further investigations] *in* Internat. Conf. Experts on Explosion Seismology, 1st. Leningrad, 1968, Trans.: Kiev, U.S.S.R., Akad. Nauk Ukrain. SSR Inst. Geofiziki (Izdatel'stvo Naukova Dumka), p. 27-37, illus., 1969.

Results of explosion seismological investigations in the United States are summarized. The upper crustal rocks have a velocity close to 6 kmps. In some areas there is a low-velocity layer in the crystalline crust. Layers with velocities of 6.8-7.0 kmps underlie the granitic upper crust. On some profiles the lower crust consists of rocks with velocities of 7.3 kmps or more. Supercritical reflections are received from the top of the mantle on a number of profiles. Upper mantle velocities range from 7.8 to 8.2 kmps, being lowest in regions of recent tectonic activity and highest in the stable parts of the continent. Isostatic equilibrium of large regions is established by way of a change in crustal thickness and corresponding change in upper mantle density. For smaller segments of the crust the problem of isostatic compensation is much more complicated. There are regional differences in upper mantle structure down to 400 km. — DBV

Healy, John H. *See* King, Chi-Yu. 01939

Healy, John H. *See* Raleigh, C. Barry. 01969

Heath, Stanley A. *See* Kesler, Stephen E. 01938

09584 **Heath, Stanley A.; Fairbairn, H. W.** Sr-87/Sr-86 ratios in anorthosites and some associated rocks, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 99-110, illus., tables, 1968 [1969].

The initial Sr-87/Sr-86 ratios for 15 anorthosite bodies lie between 0.703 and 0.706 relative to a standard value of 0.7080. As this range of values is the same as that found in continental basalts, the data support an origin for anorthosite in the upper mantle or lower crust. Origins involving derivation from sedimentary rocks seem unlikely; such sediments would be expected to have ratios upward from 0.705 to 0.720. The whole rock isochron for Adirondack charnockite gives an age of 1055 m.y. and an initial Sr-87/Sr-86 ratio of 0.7060, which is identical within experimental error to the 0.7049 value for the Adirondack anorthosite. — *from* Authors' abstract

02201 **Hedberg, Marion R.; Greenwood, William R.** Computer analysis of zircon morphology data (a contribution to geometrics): Idaho Bur. Mines and Geology Inf. Circ. 21, 15 p., illus., 1970.

Analysis of zircon morphology can be useful in distinguishing meta-igneous rocks from metasedimentary gneisses, or metasomatic granites from plutons of magmatic origin, as well as comagmatic igneous bodies from those of different magma sources. Calculations for description and comparison, laborious if done by hand, are

facilitated by automatic data processing. Observations of crystal length and width are used to calculate a series of statistics including means, standard deviations, and linear regression coefficients. A systematic record format is described, on which faceting, rounding and color observations can be sent to a computer center along with a description of comparisons desired on coded parameter card forms. Sample statistics can then be calculated for one or a set of these subclasses to test for differences in shape within a given sample, or to compare between subclasses from different rocks. — *from* Authors' abstract

Heezen, B. C. *See* Knopoff, L. 09568

09560 **Heezen, Bruce C.** Tectonic fabric of the ocean floor [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 546-547, 1969.

09569 **Heezen, Bruce C.** The World Rift System, an introduction to the symposium, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 269-279, illus., 1969.

The World Rift System includes the world-girdling Mid-Oceanic Ridge as well as rift valleys which cut deeply into the continents. Unknown two decades ago, it has within the past few years become recognized as the largest tectonic feature of the Earth's crust. Its simple, worldwide pattern is providing a key for the solution of the most fundamental problems in tectonics. — Author's abstract

02163 **Helgeson, Harold C.** Description and interpretation of phase relations in geochemical processes involving aqueous solutions: Am. Jour. Sci., v. 268, no. 5, p. 415-438, illus., 1970.

Consideration of the compositional characteristics of natural aqueous solutions and the extent to which they interact with rocks suggests that the chemical potentials of chloride components such as NaCl are commonly fixed by the composition of the aqueous phase. Under such conditions the chemical potentials of the corresponding oxide components are not independent variables but are controlled by the activity of the hydrogen ion. Recognition of the compositional constraints imposed by the aqueous phase on the chemical reactions and equilibrium among phases in geologic systems leads to an integrated thermodynamic frame of reference for description and interpretation of the phase relations, and prediction of mass transfer among silicates, sulfides, oxides, carbonates, sulfates, and aqueous solutions. — *from* Author's abstract

Helsley, C. E. *See* Hales, A. L. 01920

09333 **Helton, Lois R.** Glaciers as agents of geologic change: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 7, p. 58-59, illus., 1969.

Glaciers are one of the forces external to the crust that change the Earth's surface. At present glaciers are found at high altitudes and latitudes, and cover about 10 percent of the land surface. Movement is due in great degree to rearrangement of ice crystals. Marks of glacial movement left on rocks, trees, and landscapes are described, using Yosemite Park as an example. In addition to changes by attrition, more changes are wrought by relocation of materials. — ESL

Henyey, Thomas L. *See* Goldstein, Alan S. 01915

Herdendorf, C. E. *See* Hobson, George D. 09352

01924 **Herman, Yvonne.** Late Cenozoic Arctic oceanography [abs.]: EOS, v. 51, no. 4, p. 333, 1970.

09387 **Hersey, J. B.** Engineering applications of underwater acoustics in the ocean: Jour. Petroleum Technology, v. 21 [no. 10], p. 1277-1283, illus., 1969.

As mineral industries exploit deeper areas of the ocean, they will almost certainly rely more heavily on underwater acoustical instruments. The military have used underwater acoustics in undersea warfare since WW I, and several Navy methods and apparatus have been adapted to deep water exploration and drilling. Measurement of horizontal distances involves the effects of solar heating on sound speed, and the SOFAR channel. Some applications are described. Measurement of vertical distances includes ocean depth determination by echo sounding. Where high accuracy is necessary, submersibles are the deep-water sounding boats of the future. Some improvements in interpretation of echo soundings are described. Areas that need further investigation are slumping, and strength and stability of bottom sediments. — ESL

Hertlein, L. G. *See* Newell, N. D. 09447

09177 **Herz, Norman.** Titanium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 271-275, illus., table, 1969.

Although Arizona has no known economic deposits of titanium, there are occurrences of low-grade rutile, ilmenite, titaniferous magnetite, and titaniferous hematite that do not appear economic under present-day market conditions. Two notable concentrations of rutile which is associated with pyrite and molybdenite are known, one in Santa Cruz County and the other in Yavapai County. Ilmenite is of far greater importance than rutile as a titanium resource. Occurrences are shown on a sketch map and described in a table. — WLG

09602 **Herz, Norman.** The Roseland alkalic anorthosite massif, Virginia, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 357-367, illus., tables, 1968 [1969].

The Roseland alkalic anorthosite is about 15 km long and 4 km in maximum width; it consists of large bluish-gray megacrysts of andesine antiperthite. Charnockitic rocks occur largely as a border zone. Disregarding the chlorite facies metamorphic overprint on the Roseland body, it is similar to massif-type anorthosite in texture, structural features, tectonic environment, and associated rocks. It differs in having a much higher potassium content and somewhat higher silicon and sodium. — *from* Author's abstract

Hetland, D. L. *See* Austin, S. R. 02200

09618 **Heyl, A. V.** Some aspects of genesis of zinc-lead-barite-fluorite deposits in the Mississippi Valley, U.S.A.: Inst. Mining and Metallurgy Trans., Sec. B, v. 78, Bull. 756, p. B148-B160, illus., 1969.

These low-temperature vein and stratiform ore deposits are surficially similar, but variations in fluid inclusions, lead isotopes and trace elements, and in geologic features indicate different paths of genesis. Geologic and geochemical data suggest that concentrated Na, Ca, K chloride brines from adjacent basins, heated to 70-160°C by deep-seated alkalic magmas, in each district mingled with various other solutions; the magmatic contribution ranged from heat alone to heated differentiates containing ore-forming and trace elements. Districts that had the largest magmatic contribution are zoned concentrically in some minerals, trace elements, and lead isotopes; those where heat was the sole magmatic contribution have more irregular spotty trace-element and mineral zonations, and lead isotopes zoned in one direction across the entire basin, with the least radiogenic leads near the adjacent basins. — GDC

09155 **Heywood, W. W.; Davidson, A.** Geology, Benjamin Lake, District of Mackenzie: Canada Geol. Survey Map 1198A (also in Mem. 361), scale 1:50,000, 1969.

09252 **Heywood, W. W.; Davidson, A.** Geology of Benjamin Lake map-area, District of Mackenzie (75 M/2) [with French abs.]: Canada Geol. Survey Mem. 361, 35 p., illus., tables, geol. map, 1969.

This area, which is underlain by Archean rocks, lies within the Slave Structural Province [Northwest Territories] and comprises a northerly trending belt of deformed and metamorphosed volcanic and sedimentary rocks bounded by granitic and migmatitic rocks. Diabase dikes of Proterozoic age are the youngest consolidated rocks in the region. Most of the rocks can be correlated with the Yellowknife Group although their wide range in metamorphic grade makes correlation difficult. The region has been extensively prospected for base metal deposits; small showings of zinc, lead, silver, and copper have been located. [Map 1198A accompanies the text.] — Authors' abstract

09604 **Hietanen, Anna.** Metamorphic environment of anorthosite in the Boehls Butte area, Idaho, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 371-386, illus., table, 1968 [1969].

Anorthosite occurs as layers and lenslike masses within the Boehls Butte Formation, an aluminous garnet-mica schist. General increase in grade of metamorphism toward the Idaho batholith is indicated by a peripheral distribution of metamorphic zones from biotite in the north to sillimanite plus muscovite in the south. The occurrence of beds with andalusite, in addition to the kyanite and sillimanite, only in and next to the anorthosite masses, shows that the lowest pressures prevailed in and near the anorthosite masses, and that these pressures were near the triple point. The anorthosite is comprised of both bytownite and andesine. The bytownite probably crystallized during an early metamorphic episode and the andesine at a later stage near the triple point by introduction of sodium. — JWC

Higgs, Robert H. *See* Einwich, Anna M. 01908

Hilde, Thomas W. C. *See* Larson, Peggy A. 01943

02160 **Hills, L. V.; Wallace, Sandra.** Reworked Devonian megaspores from the Triassic Bjorne Formation, Melville Island, Arctic Canada: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 113-114, 1970.

The Bjorne Formation has been divided into three informal members; the sediments were probably derived from Devonian-Permian strata. Palynological analyses were run on muds from two of the three members and all but two of the megaspores listed are present in Devonian formations on other islands. No reworked Pennsylvanian or Permian spores were recovered. It is concluded that the Devonian of Melville Island was contributing sediments to the Bjorne throughout its depositional history. Reworked Devonian megaspores in the lowermost Bjorne indicate that Devonian strata were exposed prior to sedimentation. The absence of reworked spores from the Pennsylvanian and Permian suggests that the Devonian must have been denuded during latest Permian. — ESL

02038 **Hinds, Jim S.; Cunningham, Richard R.** Elemental sulfur in Eddy County, New Mexico: U.S. Geol. Survey Circ. 628, 13 p., illus., 1970.

Sulfur has been reported in Eddy County in Silurian to Holocene rocks at depths of 0-15,020 feet; targets of present exploration are Permian formations in the Delaware Basin and northwest shelf areas at depths less than 4,000 feet. Most reported occurrences in the shelf area are in the "Abo," Yeso, and San Andres Formations where deposition in dense dolomites is attributed to reduction of ionic sulfate by hydrogen sulfide in formation waters in zones of preexisting porosity and permeability; in the Artesia Group, some sulfur may have originated in place through alteration of anhydrite to carbonate and sulfur by metabolic processes of bacteria in presence of hydrocarbons. Exploration in Delaware Basin is in the Castile Formation where deposits are in irregular masses of carbonate rock ("castiles") enveloped by impermeable anhydrite. The castiles probably originated as collapse features; formation of carbonate rock and sulfur is attributed to reduction of brecciated anhydrite by bacteria and hydrocarbons. — *from* Authors' abstract

09178 **Hobbs, S. W.** Tungsten, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 276-281, illus., 1969.

Tungsten minerals have been found in a variety of modes of occurrence, but all of production to date has been from quartz veins and irregular replacements in metamorphic and plutonic rocks and in small amounts from placer deposits in the Little Dragoon and Camp Wood districts; lesser amounts are in manganese minerals that form small veins in granite, conglomerate, and Tertiary volcanic rocks. The location of most of the tungsten districts, mines and prospects from which some production has been reported are shown on a sketch map. — WLG

09352 **Hobson, George D.; Herdendorf, C. E.; Lewis, C. F. M.** High resolution reflection seismic survey in western Lake Erie, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 210-224, illus., 1969.

Seismic coverage, totalling 818 mi, was obtained about every five minutes of latitude and longitude west of Point Pelee. East of Pelee and Kelleys Islands the data are good, but to the west the data are poor, probably due to gaseous organic material in the bottom sediments, sand bodies, or peat. Drift thickness from drill holes and from the survey correlate well and range from 0 to 120 feet. A major reflector within the drift indicates the surface of the glacial deposits and the general pattern of late-glacial and postglacial drainage during low-level phases of Lake Erie. Offshore bedrock elevation varies between 390 and 571 feet above sea level. Bedrock highs underlie Point Pelee and the islands whereas bedrock lows in interisland areas and the central basin are readily outlined. An interpretation of preglacial drainage is presented. — *from* Authors' abstract

09381 **Hodgson, J. F.; Tiller, Kevin G.; Fellows, Martha.** Effect of iron removal on cobalt sorption by clays: Soil Sci., v. 108, no. 6, p. 391-396, illus., table, 1969.

Iron was extracted from the clay fractions from seven soils before allowing them to adsorb Co from solutions containing abundant Ca. The results indicate that it is not the crystalline structure of given clay minerals but the alteration of the structure that gives rise to the specific adsorption of Co by soil clays. — JWH

Holcombe, Troy L. *See* Johnson, G. Leonard. 01934

Hollister, C. D. *See* Phillips, J. D. 01967

Hollister, Charles D. *See* Zimmerman, Herman B. 02008

01925 **Holmes, Mark L.; vonHuene, Roland; McManus, Dean A.** Underthrusting of the Aleutian Arc by the Pacific Ocean floor near Amchitka Island [abs.]: EOS, v. 51, no. 4, p. 330, 1970.

Holser, William T. *See* Papike, J. J. 09403

02172 **Hood, Peter.** Geophysical activity surges in the western world: Mining Eng., v. 22, no. 3, p. 63-64, illus., table, 1970.

This paper tabulates the results for 1968 of a questionnaire sent to groups in the free world who deal with mining geophysics. In terms of money spent, ground geophysical surveys accounted for 49 percent of the total, airborne surveys 36 percent, and research 15 percent. Of this total, industry accounted for 79 percent and governments and universities, 21 percent. In order of expenditure Canada was first, followed by the United States, Africa, Europe, Australia, Asia, and Latin America. Further breakdowns of these data are included. — MAC

Hoover, John I. *See* Wilkniss, Peter E. 02000

Horton, J. H. *See* Corey, J. C. 02216

02126 **Hoshkiw, M. E.** Reliability of saturation-pressure method for dating time of oil accumulation: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 699-708, illus., table, 1970.

The saturation-pressure method for dating time of oil accumulation in gas-cap reservoirs operates on the principle that free gas dissolves in oil as hydrostatic pressure increases until all free gas is dissolved at "saturation pressure;' however, the method is subject to these assumptions: (1) Little or no gas is initially present in the trap and no gas is subsequently lost or gained; (2) physical and chemical properties of oil remain constant; (3) there is no change in attitude of overlying rocks and no loss in rock record; (4) migrating oil accumulates only at saturation pressure; (5) the temperature remains constant; (6) the potentiometric surface was near the land surface at the time of accumulation; and (7) hydrostatic pressure is the only significant pressure involved. Data on specific gas-cap reservoirs indicate that none of these basic assumptions hold true, and Hoshkiw concludes that the method is therefore not reliable. — BHK

Hoskin, C. M. *See* Naidu, A. S. 01957

Hostetler, P. B. *See* Christ, C. L. 02194

02195 **Howell, B. F., Jr.** Coriolis force and the new global tectonics: Jour. Geophys. Research, v. 75, no. 14, p. 2769-2772, illus., tables, 1970.

Offsets along the transform faults that displace oceanic ridges are rotated clockwise with respect to the trend of the ridges in the northern hemisphere, counterclockwise in the southern hemisphere on two-thirds of mapped faults. It is postulated that the Coriolis effect causes this deflection of suboceanic convective flow in the same fashion that it produces the Ekman spiral of ocean currents..— Author's abstract

09334 **Howell, Paul W.** The White Pass trip: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 11, p. 96-98, 1969.

The fill which once covered most of the Puget-Willamette Trough area is composed mostly of gravel beds and mud flows from the Cascade Range. In the inner valley of the Cowlitz River, Wash., glaciation is marked and several folds are exposed. The Clear Fork of the Cowlitz cuts through a lava flow over 400 feet thick, exposing columns that extend from top to bottom of the gorge. The shear zone at the heart of the Cascades is at least 13 mi wide at the pass, but may split before reaching the 1/2-mi wide zone at Dog Mtn. Formations seen down the Tieton Valley are compared with those to the west. Howell has found that the Ellensberg Formation, composed of andesitic gravels and pumice, is older than the Hood River and Troutdale. At this time, the Columbia flowed by Snipes Mtn. on the Ellensberg surface; its path west through Horseheaven country to Hood River and beyond is well marked by patches of gravel. — ESL

09138 **Hubbert, M. King.** The theory of ground-water motion and related papers (reprints of 3 papers with corrections, plus 1856 paper by Henry Darcy): New York and London, Hafner Publishing Co., 310 p., illus., 1969.

Following a new introduction by Hubbert, the book contains a corrected version of the "The theory of ground-water motion" (Jour. Geology, v. 48, pt. 1, 1940); a corrected version of "Entrapment of petroleum under hydromatic conditions" (Am. Assoc. Petroleum Geologists Bull., v. 37, no. 8, 1953); and a reprint of "Darcy's law and the field equations of the flow of underground fluids" (Assoc. Sci. Hydrology Bull., no. 5, 1957). The 1856 paper by Darcy is titled "Détermination des lois d'écoulement de l'eau à travers le sable." — MCM

01926 **Huber, Richie; Adams, William Mansfield.** Application of geophysical techniques to ground-water research on the Kona Coast, Hawaii, [abs.]: EOS, v. 51, no. 4, p. 285, 1970.

Hubert, Arthur E. *See* Shacklette, Hansford T. 01876

09416 **Huckenholz, H. G.; Schairer, J. Frank; Yoder, H. S., Jr.** Synthesis and stability of ferri-diopside, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 163-177, illus., tables, 1969.

A series of compositions in the plane diopside-wollastonite-hematite in the quaternary system CaO-MgO-Fe_2O_3-SiO_2 were prepared along the joins diopside-ferri-Tschermak's molecule, diopside-andradite, and diopside-hematite, as well as some additional points in this plane. Stable phases obtained by quenching are pseudowollastonite, hematite, and solid solutions of clinopyroxene, andradite, wollastonite, and magnetite. Unit-cell parameters of the clinopyroxene and andraditic garnet solid solutions are given. Natural ferridiopsides are found in igneous rocks that have undergone strongly oxidizing conditions; they contain small amounts of alkalis and have potassic affinities. — *from* Authors' abstract

09469 **Hudgins, A. D.** Geology of the Enon-Loch Lomond celestite deposits, Cape Breton Island, Nova Scotia [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 208-209, 1969.

09340 **Hughes, N. F.** Jurassic and Early Cretaceous pollen and spores, [Chap.] 15 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 311-329, illus., table, 1969.

The Jurassic-Early Cretaceous was a time of culmination of a very diverse gymnosperm flora and locally very abundant pteridophytes. Numerous probable extinctions at the end of this period, particularly in gymnosperm groups, are masked by forced classifications into extant higher taxa. More than 100 organ genera have been used. Selected important genera of miospores, pollen and megaspores are discussed here, arranged by Potonie's morphographic classification, but detailed botanical assignments to extant genera are not helpful in studies of pre-Quaternary plant evolution. Distribution and sequence of floras and correlation with the standard marine succession of western Europe are discussed. New types of spore and pollen apertures were evolved, culminating in appearance of true tricolpate (angiosperm) pollen in Albian time. — VMJ

Husebye, Eystein S. *See* Toksöz, M. Nafi. 01991

Husler, John. *See* Cruft, Edgar F. 09367

09301 **Husler, John W.; Cruft, Edgar F.** Atomic absorption determination of trace elements in calcium sulfate minerals using an organic enrichment technique: Anal. Chemistry, v. 41, no. 12, p. 1688-1690, tables, 1969.

In the proposed method, the sample solution containing Cd as a collector is treated with three organic reagents, and the pH is adjusted to 5.9. — AC brief

01927 **Hyndman, R. D.** Geomagnetic variations and electrical conductivity structure under Atlantic Canada [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

Ida, Y. *See* Mizutani, H. 02138

01928 **Ida, Yoshiaki.** A new estimation of melting point in the Earth's interior [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

09329 **Ilvari, T. A.** Cenozoic stratigraphy of the east-central Markagunt Plateau, Utah: Compass, v. 46, no. 4, p. 233-242, illus., 1969.

Tertiary stratigraphy of a 140 sq mi east-west belt is described. The earliest event recorded was the fluvial and lacustrine deposition of the Claron Formation. Volcanism during the closing stages is evidenced by deposits of volcanic arenite, mudflow-breccias, and mafic flows. Needles Range Formation, the lowest ignimbrite, spread across the Claron surface and covered most of the central Markagunt; this was covered by Isom Ignimbrite. North-south trending block faulting followed, forming grabens which were filled by 1,000 feet of aeolian-deposited volcanic arenite with interbeds of other volcanic material. At least 1500 feet of breccias and flows covered the central Markagunt. A period of erosion, accompanied by deposition of the Sevier River Formation, was contemporaneous with the second and main period of faulting. Quaternary basalts spread across the eastern part. — *from* Author's abstract

Internat. Nickel Company of Canada. *See* Souch, B. E. 09259

09220 **Irvine, T. N.; Smith, C. H.** Primary oxide minerals in the layered series of the Muskox intrusion, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 76-94, illus., table, 1969.

The Muskox intrusion layered series of 42 layers of 18 different rock types (6,500 feet thick) ranges with much repetition from dunite at the base through peridotite and various pyroxenites and gabbros to a discontinuous capping of granophyre. Layers are accumulations of mineral grains fractionally crystallized and settled from basaltic magma; the sequence of layers reflects the order of crystallization of minerals periodically interrupted by introduction of fresh magma. Primary oxide minerals are chromite, magnetite, and ilmenite. Chromite, disseminated in layers of dunite and peridotite having a total thickness of about 4,000 feet, is concentrated in two thin layers in peridotite below orthopyroxenite layers. Magnetite and ilmenite are settled minerals in granophyre-bearing gabbro near the top of the intrusion. Crystallization relations of the oxide minerals are consistent with available phase equilibria data. — *from* Authors' abstract

Irwin, W. P. *See* Blake, M. C., Jr. 09455

09575 **Isachsen, Yngvar W.** Origin of anorthosite and related rocks — George H. Hudson Symposium, 2d Ann., Plattsburgh, N. Y., 1966: New York State Mus. and Sci. Service Mem. 18, 466 p., illus., tables, 1968 [1969].

This symposium volume, dedicated to Arthur F. Buddington, contains 34 papers and 4 abstracts (all cited separately) on the origin of anorthosites and related rocks. The sections are entitled: experimental studies and petrogenesis, inter-regional petrogenetic studies, and regional studies and petrogenesis. The last section is comprised of descriptions of occurrences in the Canadian shield (largely the Adirondacks), Blue Ridge province, western United States, southern Norway, and India. An annotated bibliography and index are included. — JWC

09594 **Isachsen, Yngvar W.; Moxham, R. L.** Chemical variation in plagioclase megacrysts from two vertical sections in the main Adirondack metanorthosite massif, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 255-265, illus., tables, 1968 [1969].

Gravity studies indicate that the main Adirondack anorthosite mass is a subhorizontal slab 3-5 km thick. The original slab appears to be essentially intact for eventual top-to-bottom study. The possibility of relict igneous stratigraphy in the presently accessible upper half kilometer of the slab was investigated by analysis of the feldspar megacrysts. In the two sections studied, neither major nor minor elements show a systematic increase or decrease as a function of vertical position in the slab. Compositional variations do, however, indicate the existence of an igneous stratigraphy. One profile exhibits rhythmic chemical layering, whereas the other is characterized by abrupt, unpredictable shifts in composition. — *from* Authors' abstract

Isachsen, Yngvar W. *See* Reynolds, Robert C., Jr. 09595

09605 **Isachsen, Yngvar W.** Origin of anorthosite and related rocks, a summarization, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 435-445, 1968 [1969].

The data and ideas presented in this symposium on anorthosites are summarized. Radiometric ages fall in the range 1.1-1.4 b.y., and the size of the massifs is in the range 100-10,000 sq km. In addition to plagioclase, most anorthosites contain orthopyroxene, with or without augite and olivine; the mafic minerals form interstitial aggregates. A spatial relationship between anorthosite and charnockite is well documented, but the temporal and genetic relationship is debatable. Evidence for igneous emplacement is given for most anorthosites described in this volume. An hypothesis is proposed in which labradorite-type anorthosite forms near the base of the protocontinental crust penecontemporaneously with emplacement of stratiform intrusions at shallow depths and extrusion of Keewatin-type volcanics. The labradorite-type anorthosite undergoes recrystallization and then becomes partially melted at 1.7 to 1.0 b.y. ago to form the parent liquids of andesine-type anorthosite. — JWC

Isacks, B. *See* Sykes, J. Oliver. 09552

Isayev, Ye. N. *See* Gaynanov, A. G. 09154

01929 **Iyer, H. M.; Landers, T. E.** Spectral variation of teleseismic P-waves across the Large Aperture Seismic Array (LASA), Montana [abs.]: EOS, v. 51, no. 4, p. 358, 1970.

Jackson, D. E. *See* Morgan, G. R. 02159

02102 **Jackson, David D.; Anderson, Don L.** Physical mechanisms of seismic-wave attenuation: Rev. Geophysics and Space Physics, v. 8, no. 1, p. 1-63, illus., tables, 1970.

The most effective mechanisms responsible for attenuation of seismic waves seem to be associated with partial melting, grain-boundary relaxation, and a poorly understood mechanism called 'high-temperature, internal-friction background' [equation given]. In material as complex as a rock, there is unlikely to be a single discrete relaxation time or activation energy, or a single 'typical' grain size. The observed dimensionless measurement of anelasticity (Q^{-1}) is likely to result from a superposition of several mechanisms and involve a spectrum of parameters leading to weaker frequency dependence than is predicted from a single simple mechanism; the seismic data cannot at present resolve the question of whether or not Q^{-1} has an intrinsic frequency dependence. Extent and limitations of available seismic data are discussed and experimental data on attenuation of oxides are summarized. — *from* Authors' abstract

09219 **Jackson, Everett D.** Chemical variation in coexisting chromite and olivine in chromite zones of the Stillwater Complex, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 41-71, illus., tables, 1969.

From previous studies it has been concluded that in the Stillwater Complex chromitite zones where olivine and chromite occur together as cumulus minerals, they formed as simultaneous crystallization products in equilibrium with each other and the Stillwater magma. This hypothesis was tested by determining proportions and compositions of 35 coexisting olivine and chromite pairs encountered in channel samples of the G and H chromitite zones in the Mountain View area. Cation fractions of Mg and Fe^{+2} in chromite and olivine, and of Cr, Al, and Fe^{+3} in chromite, are clearly related to proportions of the two minerals in the 35 layers. Comparison of variations in cation fractions with theoretical variations indicates that observed and expected variations are of the same general magnitude and direction, and that compositions of coexisting olivine and chromite in G- and H-zone layers can be accounted for by a simple thermodynamic model. — *from* Author's abstract

09532 **Jackson, Everett D.** Discussion on the paper "The origin of ultramafic and ultrabasic rocks" by P. J. Wyllie, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 517-518, 1969.

Hypotheses holding that xenoliths are cognate cumulates or fragments of the upper mantle are not mutually exclusive, and it is essential to separate the problem of depth of origin of xenoliths from that of their process of formation. Xenoliths in basalts and kimberlites were probably stoped off from any or all levels of the mantle and crust as the material ascended from the upper mantle. Original depth of the stoped material can be determined by studies of geobarometers and rock contacts in the xenoliths and from elastic properties of both xenoliths and terrane beneath area of occurrence. Processes of formation can be determined directly from textural studies of xenoliths. Statistical counts can establish proportions of xenoliths formed at different depths by each process for each host flow; groups of counts give comparative data for host rocks of different compositions. Studies of Hawaiian xenoliths are cited as examples. — VSN

01930 **Jacob, Klaus H.** P-residuals and global tectonic structures investigated by three-dimensional seismic ray tracing with emphasis on Longshot data [abs.]: EOS, v. 51, no. 4, p. 359, 1970.

01931 **Jacoby, Wolfgang R.** A refraction profile across the southern Canadian Cordillera [abs.]: EOS, v. 51, no. 4, p. 356, 1970.

Jaffe, Howard W. *See* Robinson, Peter. 09421

09304 **Jahns, Richard H.; Burnham, C. Wayne.** Experimental studies of pegmatite genesis — [Pt.] 1, A model for the derivation and crystallization of granitic pegmatites: Econ. Geology, v. 64, no. 8, p. 843-864, illus., 1969.

The role of water is emphasized in a model for the genesis of pegmatites. Pegmatite magma, whether formed as rest liquid in cooling magma or by partial melting of crustal materials, has a water content high relative to the solubility limit at a given confining pressure. The large variety of structural types and internal structures of pegmatites is due to differences in the time of appearance and distribution of the second fluid phase — a supercritical aqueous fluid. This appearance, in turn, depends on initial abundance of water in the system and cooling history. The wide range of P-T-X conditions for pegmatites precludes a simple classification. — WSW

01932 **Jain, A. V.; Lipschutz, M. E.** The shock history and origin of chemical group IVA meteorites [abs.]: EOS, v. 51, no. 4, p. 341, 1970.

09335 **James, H. L.; Wier, K. L.** Geology and magnetic data for the southeastern Iron River area, Michigan: Michigan Geol. Survey Rept. Inv. 6, 30 p., illus., geol. map, 1969.

The area comprises about 13 square miles immediately southeast of the city of Iron River. Badwater Greenstone of the Baraga Group occupies the extreme southwestern part and is stratigraphically overlain by the Dunn Creek Slate, Riverton Iron-formation, Hiawatha Graywacke, and Stambaugh Slate of the Paint River Group. The area is in the western part of the Iron River-Crystal Falls synclinorium whose north and south limbs are present, marked by the Riverton Iron-formation. Regional geologic trends are easterly to southeasterly, but strong cross folds result in long anticlinal and synclinal projections of the geologic units. Isolated downfolds of the Stambaugh Formation, as reflected by strong magnetic anomalies, are common. Areas of outcrop, partial extent of mine workings, drill-hole and magnetic survey data are shown on two geologic maps. Data on ore bodies, mine production and known explorations are given. — *from* Author's abstract

Johnson, D. A. *See* Florence, T. M. 09300

09401 **Johnson, Donald Lee.** Beachrock (water-tablerock) on San Miguel Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 105-108, table, 1969.

Quaternary carbonate deposits occur intermittently along the northwest coast of San Miguel Island. The calcareous-cemented sandstone formed on a marine-cut bench of Quaternary age, varies from a few cm to over 60 cm thick, formed as a marine beach which was veneered with pebbles, sand, and boulders, and was exposed to subaerial eolian sedimentation of calcareous shelf sand following a drop in sea level. The carbonate was leached and disseminated by rain and ground water which moved downward along the beach-eolianite interface, and issued as springs. Evaporation resulted in precipitation of the carbonate. There seems to be no connection with the tide range. — HRC

01934 **Johnson, G. Leonard; Vogt, Peter R.; Holcombe, Troy L.** Hypothesis on the origin of North Atlantic basement topography [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

Johnson, R. B. *See* Shuey, R. T. 01977

09518 **Johnson, Ross B.** Geologic map of the Villanueva quadrangle, San Miguel County, New Mexico: U.S. Geol. Survey Geol. Quad. Map GQ-869, scale 1:62,500, section, 1969.

09510 **Joiner, Thomas J.; Scarbrough, W. Leon.** Hydrology of limestone terranes — Geophysical investigations: Alabama Geol. Survey Bull. 94, pt. D, 43 p., 1969.

This study indicates that geophysical methods can sometimes be used successfully to assist in locating, defining, and projecting general trends of solution development in limestone terranes. Geophysical anomalies that can be used as guides for test drilling are: (1) areas where a thick cover of residuum is indicated by seismic surveys; (2) areas where seismic data indicate slower-than-normal bedrock velocities; (3) areas where conductive anomalies are detected within the bedrock by "horizontal-type" electrical resistivity surveys; and (4) areas where gravity data indicate isolated "minima" and trends of lower-than-normal gravity values. Reconnaissance geophysical surveys can be used to eliminate unfavorable areas and to indicate areas where efforts of other disciplines should be concentrated. [Studies were conducted in the Athens and Elkmont quadrangles.] — Authors' abstract

09132 **Jones, J. F.** Groundwater-streamflow interactions [with French abs.], *in* Groundwater-streamflow systems — Canadian Natl. Comm. Hydrol. Decade and Laval Univ., Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, p. 3-13, illus., discussion [1969?].

Perennial streams are generally effluent during low water conditions, but streams that are hydraulically connected to the aquifers feeding them may be influent during high water conditions. In contrast, streams in mountainous areas usually receive more ground-water runoff during periods of high water. Influent streams are important sources of ground-water recharge in arid regions. Part 1 of this paper deals with the physical aspects of ground water-streamflow interactions and includes a discussion of some of the methods of determining the quantity and distribution of groundwater runoff. Part 2 considers suggested methods of using water chemistry to construct a base flow hydrograph, to investigate the phenomena of bank storage, and to determine the contribution of base flow from various aquifers. Several experiments are currently underway in Nova Scotia to evaluate these methods. — Author's abstract

02111 **Jongejan, A.; Wilkins, A. L.** A re-examination of the system $CaO\text{-}TiO_2$ at liquidus temperatures: Jour. Less-Common Metals, v. 20, no. 4, p. 273-279, illus., table, 1970.

The liquidus curve of the system $CaO\text{-}TiO_2$ has been determined by hot-stage microscopy. The shape of the curve on the TiO_2-rich side of perovskite, $CaO\text{-}TiO_2$, approximately coincided with that determined by DeVries, Roy and Osborn, except for a possible slight discontinuity at approximately 1870°C. A significant discontinuity on the CaO-rich side of the perovskite curve was observed at the same temperature level. Its location suggested the existence, at least at high temperatures, of a compound possibly having the composition $4(CaO)3(TiO_2)$, and/or that of a transformation to a high-temperature form of perovskite. The position of the eutectic with CaO and, consequently, that of the CaO curve appeared to be richer in TiO_2 than was indicated by the results of cone-fusion methods used by other investigators. — Authors' abstract

Judge, Charles W. *See* Hawley, Eugene F. 09351

01935 **Julian, Bruce R.** Regional variations in upper mantle structure of North America [abs.]: EOS, v. 51, no. 4, p. 359, 1970.

09495 **Kalliokoski, J.; Cathles, L.** Morphology, mode of formation, and diagenetic changes in framboids: Geol. Soc. Finland Bull., no. 41, p. 125-133, illus., 1969.

Pyrite framboids represent cubic close packed supermolecular colloid aggregates or "crystals," probably formed by a process of coacervation and particulation due to the reaction of ferruginous humic acid with biogenic H_2S. The structures are enlarged and show morphological changes due to later diagenetic effects. — Authors' abstract

02128 **Kanamori, H.; Press, Frank.** How thick is the lithosphere?: Nature, v. 226, no. 5243, p. 330-331, illus., 1970.

A rapid decrease in shear velocity in the suboceanic mantle is used to infer the thickness of the lithosphere. It is proposed that new and highly precise group velocity data constrain the solutions and imply a thickness near 700 km. — Authors' abstract

01936 **Kanamori, Hiroo.** The Alaska earthquake of 1964, radiation of long-period surface waves and source mechanism [abs.]: EOS, v. 51, no. 4, p. 355, 1970.

Kanamori, Hiroo. *See* Wu, Francis T. 02004

01937 **Kanasewich, E. R.; Clowes, R. M.** The nature of seismic reflecting horizons near the base of the crust [abs.]: EOS, v. 51, no. 4, p. 356, 1970.

09574 **Kanasewich, E. R.; Clowes, R. M.; McCloughan, C. H.** A buried Precambrian rift in western Canada, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 513-527, illus., 1969.

Reflection seismic, gravity and magnetic data indicate the presence of a Precambrian rift in southern Alberta beneath 2.5 km of flat-lying Paleozoic and Mesozoic sediments. Several deep reflecting horizons, apparently continuous over at least 100 km, outline a major E-W graben in the basement; a horizon at an average depth of 30 km shows dips to 20° and faults with vertical displacements as much as 5 km. Reflected energy from depths of 38-47 km probably correlates with the M-discontinuity on the basis of refraction data. This horizon also appears to be involved in the faulting. A combination of seismic velocities and Bouguer anomalies is used to develop a crustal model which indicates that the rift on the Precambrian surface is filled with lighter density material. The feature has been traced by gravity and magnetic trends for several hundred kilometers across Alberta and under the Rocky Mts. into British Columbia. — *from* Authors' abstract

09353 **Kapp, Ronald O.; Bushouse, Stephen; Foster, Benjamin.** A contribution to the geology and forest history of Beaver Island, Michigan, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 225-236, illus., 1969.

Pollen analysis and the character of the sediments from two basins on Beaver Island, Michigan permit a tentative correlation between water level in the Michigan basin, sedimentation and forest history. Three pollen zones from a post-Valders peat bog and Barney Lake reflect a late-glacial forest, dominated by spruce followed by the development of the mixed northern hardwood forest including pine. Beech and hemlock migrated to Beaver Island about 7,300 years B.P. The sediments correlate with fluctuation in water level in the Lake Michigan Basin. The high water levels of Lakes Algonquin and Nipissing deposited sand in the Barney Lake basin. A peat horizon near the base of the Barney Lake sediments C-14 date at 7,280 ± 160 years B.P., and was formed during a period when Barney Lake was nearly dry, probably during the time of the Lake Chippewa low water stage. — Authors' abstract

Kashuba, A. T. *See* Morrison, G. H. 09370

09498 **Kauffman, Erle G.** Form, function, and evolution, *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N129-N205, illus., tables, 1969.

The study of adaptive functional morphology, defining relationships between the animal in life, its skeletal components, environment, and evolution, is basic to all paleontologic interpretation. Bivalvia are particularly well suited to interpretive study: they are commonly well preserved as fossils; many long evolutionary lines have living descendants of homeomorphs; shell morphology reflects the soft parts and, commonly, the preferred habitat. Functional morphology of the shell is discussed here within eleven broad categories of living habit: epifaunal, comprising byssate, cemented, and free-living forms; semi-infaunal; infaunal, comprising detritus feeders,

filter feeders, and borers. As an example, evolutionary trends are interpreted for Cretaceous lineages of the lucinacean *Thyasira*, of western interior U. S., showing adaptation of the shell for rapid burrowing. — VMJ

02079 **Keefer, William R.** Structural geology of the Wind River basin, Wyoming: U.S. Geol. Survey Prof. Paper 495-D, p. D1-D35, illus., tables, geol. map, 1970.

The Wind River basin is an extensive crustal depression surrounded by broad anticlinal uplifts, including the Wind River Range on the west, the Washakie Range and Owl Creek and southern Bighorn Mountains on the north, the Casper arch on the east, and the Granite Mountains on the south. Paleozoic and Mesozoic strata dip 10°-20° basinward along the west and south edges of the basin, but are commonly vertical to overturned along the north and east margins. Relatively undeformed lower Eocene rocks cover the central basin area. Deformation (Laramide) took place chiefly in latest Cretaceous, Paleocene, and earliest Eocene times; total structural relief exceeds 30,000 feet along some reverse fault zones. Laramide structures were modified in places by late Tertiary normal faulting. — WRK

Keen, A. Myra. *See* McAlester, A. L. 09445

Keen, A. Myra. *See* Newell, N. D. 09447

Keen, A. Myra. *See* Newell, N. D. 09451

Keen, A. Myra. *See* Chavan, André. 09497

09181 **Keith, S. B.** Alunite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 301-303, table, 1969.

The possibilities for mining alunite in Arizona has attracted little interest in recent years. The known deposits, principally at Sugarloaf Butte, are too small to serve as the raw material for an aluminum industry, and the value of the deposits for other uses is decreased by their low grade and high sodium content. Some possibility remains that large high-grade alunite deposits will be found in Arizona in the future. However, the prospects for such discoveries cannot be considered bright, because alunite tends to occur in rocks favorable for metallic mineral deposits, and most such rocks have been thoroughly prospected. — Author's outlook

09186 **Keith, S. B.** Feldspar, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 342-348, illus., table, 1969.

Pegmatites, the only known commercial source of feldspar in Arizona, occur in many parts of the State but mainly in older crystalline rocks exposed within an irregular, southeastward curving belt extending from Lake Mead, Mohave County, to Cochise County. Many pegmatites within this belt have been studied or prospected, but few have warranted development and testing for possible commercial feldspar production. The only deposits that appear to be of commercial value are the Taylor deposit near Kingman and those in the White Picacho district. — WLG

09189 **Keith, S. B.** Granitic rocks, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 364-368, illus., 1969.

Granitic rocks which occur in considerable quantities throughout the southwestern half of Arizona can be divided into two main groups: Precambrian, and Mesozoic-Cenozoic. Precambrian granitic intrusive and granite gneiss bodies crop out in a wide band extending from northwest to southeast; their character and quality is highly variable. Mesozoic granitic rocks crop out mainly in Cochise and Yuma Counties; Laramide granitic intrusives and gneisses, scattered throughout much of the Basin and Range province, consist of batholiths and stocks, or metamorphic masses associated with the intrusives; most larger granitic bodies crop out in Pima and Santa

Cruz Counties, and many have closely associated hydrothermal mineral deposits, thus showing considerable alteration which may make them unsuitable as commercial stone. The youngest granitic intrusions (Tertiary) occur mainly in Cochise County; some of this granite may be exploitable. — WLG

09190 **Keith, S. B.** Guano, nitrate, and phosphate, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 368-371, 1969.

Arizona does not appear to have appreciable resources of nitrates and phosphates. Bat guano, which contains both these commodities, has been exploited to a limited extent in the State and noncommercial occurrences of nitrate and phosphate have been reported. Nitrates and phosphates are essential to plant and animal life and although Arizona is apparently deficient in commercial deposits of these commodities their occurrence and possibility of occurrence in the State are discussed briefly. — Author's introduction

09191 **Keith, S. B.** Gypsum and anhydrite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 371-382, illus., table, 1969.

Three general periods of gypsum-anhydrite deposition are recognized in Arizona: late Paleozoic, early Mesozoic, and Cenozoic. A table lists the principal gypsum mines and occurrences and a sketch map shows their location; the active and inactive mines in 1966 are noted. Reported occurrences of anhydrite, except in deep drill holes, are rare and are of no economic significance. Logs of deep drill holes in the Willcox area of Cochise County, the Salt River Valley area west of Phoenix, the Hualapai Valley area, and the Supai Basin area in east-central Arizona, show gypsum and anhydrite beds at depths ranging from a few hundred to 2,000 feet. At these depths they are not exploitable, but they mark gypsiferous zones that may be traced to outcrops and thus can be of economic interest. — WLG

09192 **Keith, S. B.** Limestone, dolomite, and marble, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 385-398, illus., tables, 1969.

Of the many sources of limestone, magnesian limestone, dolomite, and marble in Arizona, only a few have been or can be quarried for commercial and industrial purposes because of difficult access and limited markets. The two best limestones for overall purity, thickness, and availability over wide areas are the Mississippian Escabrosa and Redwall Limestone; the former crops out mainly in the folded and faulted southeastern mountain ranges, and the latter occurs in less disturbed form bordering the Colorado Plateaus province from east-central to northwestern Arizona. Marble probably derived from the Escabrosa, is exposed in scattered outcrops throughout the southeastern section; most is highly fractured, contains cross-cutting igneous dikes, or has color variations which limit size of blocks or amounts having uniform color or color pattern. — MCM

09195 **Keith, S. B.** Pumice and pumicite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 407-412, illus., 1969.

Although the reserves and resources of pumice and pumicite in Arizona are large, amounting to many millions of tons, it is doubtful if any can be economically exploited as abrasive material. In the construction industry in Arizona, pumice has been used as a pozzolan for the Glen Canyon Dam and to a limited extent as lightweight aggregate in concrete blocks. With further experimenting and testing, additional construction uses may be found. Pumicite occurs mainly in northeastern Arizona within the Navajo-Hopi Indian Reservations as thin beds in the Cenozoic Bidahochi Formation. Unless new markets for use can be developed, future production is likely to be minimal. — WLG

09196 **Keith, S. B.** Quartz and quartzite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 413-417, illus., 1969.

Most quartz and quartzite produced in Arizona have been used for metallurgical flux by the copper smelters. Major deposits are of Precambrian or Cambrian age and include the Troy, Dripping Spring, Bolsa, and Coronada Quartzites, of sedimentary origin, in southern Arizona, and the Shinumo Quartzite and metamorphic quartzite beds of the Vishnu Schist in the Grand Canyon area. The Precambrian Mazatzal Quartzite occurs in scattered localities in central Arizona, but appears to be of little commercial importance. Most of the quartzites or formations containing quartzite units are listed in a table. — WLG

09198 **Keith, S. B.** Sand and gravel, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 424-441, illus., tables, 1969.

Arizona has ample reserves and resources of sand and gravel for constructional purposes but remoteness from markets and limited accessibility of many deposits limit their exploitation. Amount and quality of deposits vary greatly between localities because of different geologic, topographic, and climatic conditions. Based on these characteristics, Arizona can be divided into three regions: plateau, mountain, and basin regions. Each region is described briefly; tables give the general uses, specifications, supplies of sand and gravel, and tonnage of sand and gravel produced by counties in 1966; and figures show the annual tonnage and value of sand and gravel produced in Arizona from 1900-66. — WLG

09199 **Keith, S. B.** Sandstone, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 441-448, illus., table, 1969.

Good sandstone for dimension stone is abundant in northern Arizona; highest quality stone and principal source of production at present is the Permian Coconino Sandstone which is eolian in origin and has medium- and uniformly-sized quartz grains, well cemented with silica, and underlies either the Hermit Shale or the Supai Formation throughout a large part of the Colorado Plateau province. Another major deposit in the Triassic Moenkopi Formation consists of nonmarine, sandy and silty red beds that interfinger with thin, marine, calcareous sediments. A table shows production and use of dimension sandstone for 1966. — WLG

09230 **Keith, S. B.** Basalt and related rocks, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 315-320, illus., table, 1969.

The major center of commercial production of basaltic rocks has been from cinder cones around Flagstaff. The largest producer, the Santa Fe Railway, quarries and stocks volcanic cinders at Winona for its use as railroad ballast and for rail shipment to other users throughout the State as ballast, aggregate for concrete and for cinder blocks. Smaller commercial amounts have been produced in other counties from north of Phoenix, west and southwest of Tucson, and from areas around Kingman, Ashfork, and Williams. The producers and uses of basalt and related rocks are listed in a table and the principal source areas and quarries are shown on a sketch map. — WLG

09619 **Keith, S. B.** Shale, slate, and miscellaneous stone products, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 449-453, 1969.

Arizona has large and varied shale resources; Paleozoic, Mesozoic, and Cenozoic sedimentary sequences all contain shale beds in most parts of the State, but no detailed study of their potential use has been made. Large areas containing mica and clay slate in Precambrian rocks were found in western Arizona, but it is doubtful if good dimensional slate can be economically exploited except as flagstone or for spe-

cial decorative purposes. The production of schist has been mostly from Precambrian rocks in Maricopa, Mohave, Yavapai, and Yuma Counties. Colorful and decorative schist are in demand for facing stone, and its production has become an important business. Other minor stone products such as rhyolite and rhyolite tuff, some jasper, finely crystalline silica, silicified carbonate rock (magnesite) and some serpentinized rock have been produced and used mainly for construction or for decorative purposes. — WLG

02148 **Kelly, T. E.; Paulson, Q. F.** Geology and ground water resources of Grand Forks County — Pt. 3, Ground water resources: North Dakota Geol. Survey Bull. 53, pt. 3 (North Dakota Water Comm. County Ground Water Study 13), 58 p., illus., tables, 1970.

Ground water is obtainable in Grand Forks County both from bedrock aquifers (Ordovician rocks and Cretaceous Dakota Group and Pierre Formation) and from overlying glacial drift deposits. Sustained yields up to 500 gpm have been pumped from the Dakota in the eastern section. Water from bedrock aquifers is generally very saline. Five major aquifers delineated by test drilling are the Elk Valley, Inkster, Emerado, Grand Forks, and Thompson; the first two are most productive and yield best quality of water. Regional ground-water movement is eastward; eastern Grand Forks County is part of a large artesian discharge area. Geochemical data indicate a progressive water quality change eastward across the county from a low-salinity calcium bicarbonate type to a high-salinity sodium sulfate chloride type. — *from* Authors' abstract

09441 **Kemp, A. L. W.** Organic matter in the sediments of Lakes Ontario and Erie, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 237-249, illus., tables, 1969.

Organic and carbonate carbon were determined in six cores from Lake Ontario and four from Lake Erie. Ontario sediments are black, laminated gray silty clay muds overlying grey glacial clay. Organic carbon decreased from 50 percent in the top 20 cm of sediment and decreased to 1 percent at the glacial clay contact. Lake Erie sediments are uniform grey silty clay mud with a similar decrease in organic carbon to Lake Ontario. Bitumens accounted for 3-6 percent of the organic matter, humic and fulvic acids for 19-27 percent, and kerogen for 35 to 49 percent in the surface centimeter of sediments in the main basin of the two lakes. — *from* Author's abstract

01938 **Kesler, Stephen E.; Heath, Stanley A.** Structural trends in the southernmost North American Precambrian, Oaxaca, Mexico [abs.]: EOS, v. 51, no. 4, p. 421, 1970.

02129 **Khan, Mohammad Asadullah; Woollard, George P.** Geophysical implications of the interrelationship of the geogravity and geomagnetic fields: Nature, v. 226, no. 5243, p. 340-342, illus., tables, 1970.

The degree correlation function between the anomalous gravity field and the nondipole part of the geomagnetic field (secular variations) is significantly positive only for $n = 3$ and $n = 4$, with an unmistakable peak in the third harmonic. Geoidal undulations and the geomagnetic secular variations arising from the third and fourth harmonics show patterns that are clearly correlated within the frequency range represented in the maps. It is proposed that the correlation is mainly due to the effect of lateral temperature variations in the upper mantle on both of the force fields. It is shown how gravity lows over the hotter upper mantle match geomagnetic isoporic lows and gravity highs over colder mantle match isoporic highs. — DBV

Klilsgaard, Thor H. *See* Becraft, George E. 01878

09222 **Kilburn, L. C.; Wilson, H. D. B.; Graham, A. R.; Ogura, Y.; Coats, C. J. A.; Scoates, R. F. J.** Nickel sulfide ores related to ultrabasic intrusions in Canada, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 276-293, illus., tables, 1969.

Canadian nickel sulfide ores related to ultrabasic rocks are divided into orogenic deposits, related to ultrabasic intrusions along or adjacent to major faults, and volcanic deposits, distributed through thick volcanic sequences as interflow sills and dikes. In both, nickel sulfides occur as disseminations within the ultramafic intrusion, and as massive and stringer zones at the contact and within adjacent wall rocks. The sulfide assemblage in most deposits comprises pyrrhotite, pentlandite, pyrite, chalcopyrite, and magnetite. Important exceptions are millerite, pentlandite, pyrite, and chalcopyrite at Margridge No. 2, Quebec, and high pyrite at Shebandowan, Ontario. Petrographic studies reveal progressive recrystallization with serpentinization. In orogenic deposits, ultrabasic rocks are predominantly peridotite and pyroxenite and disseminated sulfide is the most common occurrence; in volcanic, rocks are peridotite with gabbro and contact deposits most common. — VSN

Kilburn, L. C. *See* Wilson, H. D. B. 09264

Kim, R. Y. *See* Hardy, H. Reginald, Jr. 01922

Kimble, E. J. *See* Hardy, H. Reginald, Jr. 01922

02125 **Kimmel, Grant E.; Schiner, George R.** The Shenango Formation (Mississippian) in northwestern Pennsylvania: U.S. Geol. Survey Bull. 1294-C, p. C1-C13, illus., 1970.

The top two units of Mississippian rocks are herein defined as upper and lower members of the Shenango Formation. The upper member is mostly shale, and the lower member is principally sandstone and subordinate interbedded shales. A type section is established for the Shenango Formation which is about 150 feet thick in the Shenango River valley. Measured sections and gamma-ray logs of wells show that the individual sandstones of the lower member of the Shenango Formation are not mappable units. The upper member of the Shenango Formation has been correlated by previous workers with the Hempfield Shale, but detailed geologic mapping by the authors indicates that the name Hempfield Shale was applied to a nonmappable shale within the Shenango Formation. The Hempfield Shale is herein abandoned. — Authors' abstract

09480 **Kimura, E. T.; Drummond, A. D.** Geology of the Endako molybdenum deposit: Canadian Mining and Metall. Bull., v. 62, no. 687, p. 699-708, illus., 1969.

The Endako deposit, 100 miles west of Prince George, B.C., in the composite Jurassic Topley Intrusions, occurs in older Endako quartz monzonite bounded by other igneous bodies. The orebody is an elongated ellipse, striking N 70° W, and dipping 20°-50° south. In the vicinity, the quartz monzonite is intruded by pre-mineral aplite, porphyritic granite, and quartz-feldspar porphyry, and post-mineral basalt dikes. Mineralogy consists of quartz, molybdenite, pyrite, magnetite, and calcite. Hydrothermal alteration has locally produced K-feldspar, and quartz-sericite-pyrite envelopes, and has kaolinized the host rock. The orebody, a restricted stockwork formed on an elongated east-west dome by uplift and intrusion and localized at the intersection of regional east-west and northwest fault systems, is classified as a low-grade porphyry-type deposit. — *from* Authors' abstract

Kimura, E. T. *See* Drummond, A. D. 09481

01939 **King, Chi-Yu; O'Neill, Mary E.; Healy, John H.** Source parameters of the Salmon and Sterling nuclear explosions [abs.]: EOS, v. 51, no. 4, p. 345, 1970.

09172 **King, Robert U.** Molybdenum and rhenium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 230-238, illus., table, 1969.

The known resources of molybdenum in Arizona are about 450,000 tons of metal chiefly in copper-molybdenum ores containing from 0.005 to 0.05 percent molybdenum. Potential resources of molybdenum are estimated to equal the known reserves for total molybdenum resources of about 900,000 tons of metal. These resources, chiefly in low-grade copper-molybdenum ores, are largely in Graham,

Greenlee, Mohave, Pima, Pinal, Santa Cruz, and Yavapai Counties. While few data are available on which to base an estimate of the total rhenium resources, there appear to be a few hundred tons of this metal associated with the molybdenum resources. A sketch map shows the principal molybdenum deposits and these occurrences are described briefly in a table. — WLG

02023 **Kingston, Gary A.; Miller, Robert A.; Carrillo, Fred V.** Availability of U.S. chromium resources: U.S. Bur. Mines Inf. Circ. 8465, 23 p., illus., tables, 1970.

Chromium resources in the United States are estimated to be 1.8 million short tons of recoverable chromium, at costs up to 64 cents per pound of chromium (Cr), contained in 22.5 million short tons of chromite-bearing material. An additional resource is presumed existent in large, but as yet undetermined, quantities of material containing less than 10 percent Cr_2O_3. No domestic resources are being mined currently (1969). Domestic chromium resources are described by state. — VPB

Kirkland, Douglas W. *See* Anderson, Roger Y. 09205

Kirkland, Douglas W. *See* Anderson, Roger Y. 09206

09207 **Kirkland, Douglas W.; Anderson, Roger Y.** Composition and origin of the Rita Blanca varves, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 15-46, illus., tables, 1969.

Three types of cyclic deposits are present in the lower Rita Blanca deposits. One type (the largest) consists of sandstone beds alternating with limestone and calcareous clay; a second is an alternation of light-colored, carbonate-rich and dark-colored, carbonate-poor clay within one thick clay-limestone bed in the larger sequence. These clay and limestone units contain alternating light and dark laminae which are seasonal varves. The clay-limestone alternations (centimeters and decimeters) are long term cycles, and the smaller laminations (millimeters) are considered varves and are seasonal. The smaller couplets are about 300 per ft of section, and the lateral thickness remained constant for at least 300 years. The petrology of the varves and large cycles is discussed in detail; evidence is given for the seasonal and annual nature of varves. — HRC

09209 **Kirkland, Douglas W.; Anderson, Roger Y.** Systematic list of fossils inthe Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 77-81, 1969.

A complete biotic list of the organisms from the lake beds is given. Over 50 plant types and over 70 types of animals are present. The most abundant types are an alga, *Botryococcus*; pollen of *Artemisia*, Gramineae, and *Quercus*; leaves of *Quercus* and *Salix*; the ostracodes *Limnocythere* and *Cyprideis*; dragonfly nymphs of the Family Libellulidae; midge pupae and adults of *Chironomus*; and the killifish *Fundulus*. In addition, there are a number of less common forms that add significantly to the environmental interpretation or the completeness of the reconstruction. — HRC

Kirkland, Douglas W. *See* Anderson, Roger Y. 09217

01940 **Kisslinger, Carl; Cherry, J. T., Jr.** Excitation of earthquakes by underground explosions [abs.]: EOS, v. 51, no. 4, p. 353, 1970.

Kister, L. R. *See* Ligner, J. J. 09265

Kistler, R. W. *See* Willden, Ronald. 09517

01941 **Klappenberger, Fred A.** Distribution of short period P-phase amplitudes at LASA [abs.]: EOS, v. 51, no. 4, p. 358, 1970.

09236 **Klemic, Harry.** Iron, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 168-182, illus., tables, 1969.

The iron resources of Arizona are largely in deposits that at present can only be classed as potential ores; these include low-grade deposits of Lake Superior types, alluvial deposits of magnetite, and smaller deposits of magnetite, hematite, and limonite. Metallurgical slags accumulated in the processing of nonferrous ores are another source of iron. The distribution of iron deposits is shown on a map, and a summary of the available resource data is tabulated. The deposits are described in the text under bedded, alluvial, and massive types. — WLG

09603 **Klugman, M. A.** The geology and origin of the Laramie Anorthosite mass, Albany County, Wyoming [abs.], *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 369, 1968 [1969].

09524 **Knopoff, L.** Structure of the low-velocity channel and its relationship to large-scale tectonics [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 403-404, 1969.

09568 **Knopoff, L.; Heezen, B. C.; MacDonald, G. J. F.** (editors). The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, 586 p., illus., tables, 1969.

The papers in this special volume are based on the "Symposium on the World Rift System" sponsored by the International Upper Mantle Committee at the XIV General Assembly of the International Union of Geodesy and Geophysics, Zurich, Switzerland, in 1967. Many of the papers were revised in 1969 for inclusion in this volume. Eight papers are cited separately. — VSN

09326 **Kohout, Douglas L.; Malcuit, Robert J.** Environmental analysis of the Bedford Formation and associated strata in the vicinity of Cleveland, Ohio: Compass, v. 46, no. 4, p. 192-206, illus., table, 1969.

The Berea, Bedford, and Ohio Formations were thought to have been deposited in three separate cycles. The writers, finding this concept inadequate to explain the lithofacies, restudied the strata along the outcrop south of Cleveland. Six lithofacies units were recognized, and from these, six environments of deposition were deduced. Except for the top fluvial sandstones, the lithofacies appear to have been deposited in a conformable regressive sequence. In this area the fluvial unit has an erosional contact with underlying rocks, but in central and southern Ohio it is conformable, representing a diastemic time-break. The sequence is unusual in that the basal black marine shale, commonly attributed to deposition in a deep marine environment, is unconformably overlain by shallow marine deposits. In the authors' opinion its properties can be explained by deposition in a density-stratified, shallow marine basin. — *from* Authors' abstract

Koopmans, L. H. *See* Anderson, Roger Y. 09208

01942 **Kosalos, James G.; Lewis, Brian T. R.; Dorman, LeRoy M.; Meyer, Robert P.** An ocean refraction experiment range 85-1,500 kms [abs.]: EOS, v. 51, no. 4, p. 356, 1970.

09279 **Kosanke, Robert M.** Mississippian and Pennsylvanian palynology, [Chap.] 12 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 223-269, illus., table, 1969.

Most Carboniferous spores and pollen are probably from vascular land plants — pteridophytes and gymnosperms. Of more than 160 generic names mentioned here, the more important are discussed in detail under two headings: small spores (miospores), including homospores, (male) microspores, prepollen, and pollen, generally smaller than 0.20 mm; and (female) megaspores, generally larger than corresponding microspores and in a few cases entirely different in form. Most Paleozoic spores can be placed in two groups based on symmetry of aperture: bilateral monolete, abundant in Pennsylvanian but rare in older rocks; radial trilete, abundant throughout the Carboniferous. Classification and nomenclature are reviewed — most modern systems are based on morphologic features such as equatorial structures. Pa-

lynomorphs useful as guide fossils are reviewed and possible botanical affinities are discussed. — VMJ

Kosminskaya, I. P. *See* Drake, C. L. 09521

09216 **Koster, William J.** Fishes of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 135-139, 1969.

Fundulus zebrinus, the southwestern plains killifish, and *Lepomis megalotis*, the longer sunfish, are recognized from seventy-six fish fossils recovered from the lake. These are the first fossil records of these species which today inhabit the shallow waters of lakes and streams of the southern High Plains. The specimens are from the zone near the base of the varve sequence in the lake beds where the fish had apparently been transported and buried. The preservation ranges from poor to good, and although bones of most specimens are badly crazed or fractured, the pigment melanin is visible in many. — *from* Author's introduction

09458 **Kosuge, Sadao.** Fossil mollusks of Oahu, Hawaii Islands: [Tokyo] Natl. Sci. Mus. Bull., v. 12, no. 4, p. 783-794, illus., table, 1969.

Elevated 5 or 6 meters above present Hawaiian shorelines are fringes of exposed coral-reef limestone, some far inland, in which abundant fossilized remains of marine shells, sea urchins, calcareous coralline, and corals indicate a past higher sea level. Listed from Oahu are 191 species studied by the author, of which 62 species of Gastropoda and 20 bivalves (Ostergaard, 1928) were in the Bishop Museum; others were examined in the field. The number of extinct or rare species of recent forms is interesting. Some are universally extinct; others, not known to be living in Hawaiian waters, are common in other Indo-Pacific regions. It is assumed that ocean temperatures were warmer when the Hawaiian limestone and the equivalent Numa limestone of Japan were formed 8,000 to 6,000 years ago, during the third postglacial or earlier time; after the damaging fourth glacial age, many species regained their northern distribution, but the ocean distance was too great for all. — GDC

Kovach, Robert L. *See* Wesson, Robert L. 01999

09583 **Kranck, E. H.** Anorthosites and Rapakivi, magmas from the lower crust, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 93-97, illus., table, 1968 [1969].

The anorthosite-mangerite suite of Precambrian shields and the rapakivi-Labrador porphyry association of the Scandinavian countries are formed from closely related magmas; which of these rock associations will form seems to depend on the level at which the differentiation and crystallization takes place. The anorthosite suite originates at great depth, the rapakivi suite near the Earth's surface and in some cases forms flow rocks; intermediate between these extremes are the rocks of the Sept Ile pluton in Quebec, Canada. In agreement with Michot (1965) the author believes the magmas were formed in the boundary zone between the basalt layer and the lower sial, probably in a cratonic environment poor in water; the amount of vertical ascent of the different magmas involved was controlled mainly by their heat energy. — *from* Author's abstract

Kregear, R. D. *See* Adams, C. E. 09347

02020 **Krouse, H. R.; Modzeleski, V. E.** C^{13}/C^{12} abundances in components of carbonaceous chondrites and terrestrial samples: Geochim. et Cosmochim. Acta, v. 34, no. 4, p. 459-474, illus., tables, 1970.

The C-13/C-12 compositions of components from nine carbonaceous chondrites were measured mass spectrometrically. The carbonates are significantly enriched in C-13, with δC-13 usually ranging from +40 to +60 percent PDB. The residue from acid treatment was as low as -27 percent. Bulk isotopic composition of specimens from any one meteorite varied considerably, dependent upon relative concentrations

of carbonate and organic matter. The saponifiable fraction in Orgueil had a δC-13 value of -25 percent, while the nonsaponifiable was -13 percent PDB. A number of terrestrial samples were also examined. Similar fractionation patterns were found, but the C-13/C-12 variations were smaller by a factor of 3 than the equivalent ones in meteorites. Possible mechanisms for the meteoritic trends are discussed. — DBV

02187 **Krummenacher, Daniel.** Isotopic composition of argon in modern surface volcanic rocks: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 109-117, illus., tables, 1970.

A study of the Ar-40/Ar-36 and Ar-38/Ar-36 ratios in argon extracted from 27 modern surface volcanic rocks shows that fractionation, along with contamination by nonatmospheric argon inherited from the parent magma, is an important cause of anomalous Ar-40/Ar-36 ratios in these rocks. — Author's abstract

Ku, Teh-Lung. *See* Bischoff, James L. 01898

Ku, Teh-Lung. *See* Bender, M. L. 02136

09223 **Kullerud, G.; Yund, R. A.; Moh, G. H.** Phase relations in the Cu-Fe-S, Cu-Ni-S, and Fe-Ni-S systems, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 323-343, illus., 1969.

Phase relations in the Cu-Fe-S, Fe-Ni-S, and Cu-Ni-S systems show that at elevated temperatures extensive liquid immiscibility fields span the sulfur-rich region of the systems, whereas homogeneous liquid fields dominate phase relations in central portions. Average composition of Sudbury Cu-Fe-Ni sulfide ore, projected onto the Cu-Fe-S plane, is accounted for above 860°C by a mixture of Cu containing hexagonal pyrrhotite and Cu-rich sulfide liquid. Minerals of the Cu-Ni-S system, with rare exception of millerite, do not occur in Sudbury-type ores. Applications of phase relations in the Cu-Fe-S and Fe-Ni-S systems to typical ore assemblages show that extensive reequilibration took place among sulfides after initial deposition. Sulfides in Sudbury-type ores commonly have compositions and crystal structures producible in the laboratory only at low temperatures. — *from* Authors' abstract

Kullerud, G. *See* Craig, J. R. 09224

Kulm, L. D. *See* Duncan, John R. 01895

02180 **Kumazawa, Mineo.** Reply [to comments by D. Weidner and R. Madariaga on "The elastic constant of polycrystalline rocks and nonelastic behavior inherent to them" (1969)]: Jour. Geophys. Research, v. 75, no. 14, p. 2790-2792, 1970.

The paper under discussion by Weidner and Madariaga (ibid., p. 2787-2789) was cited in *Abstracts of North American Geology* for March 1970. — DBV

09251 **Kumpera, Otakar; Škvor, Vladimir.** Contribution to the information on the geological development and structure of Cuba and the Caribbean region [with Czechoslovakian abs.]: [Czechoslovakia] Ustřed. Ústav. Geol. Věstník, v. 46 [!44], no. 1, p. 39-51, illus., 1969.

Cuba, like other Antillean islands, exhibits two or three linear structural trends, intersecting in the Province Habana; trends are ESE-WNW, NE-SW, and southeastern. Ultrabasic igneous rocks, homogeneous massifs, dipping into the Bartlett Trough in the Province Oriente, are serpentinized in a belt along the north coast in a Cretaceous metasedimentary-volcanic complex. With transverse depressions filled by younger deposits, the whole belt is essentially a large block-faulted graben. Ultrabasics are intruded along its deep suture, which is related to global structures in adjacent continents and the Pacific Ocean. Not an island arc in the usual sense, the Antilles developed as belts of islands intersecting in various directions, controlled by deep faults, in cycles of uplift and sedimentation, tectonic and volcanic activity. — GDC

09559 **Kuno, Hisashi.** Origin of basaltic magmas and of ultramafic rocks — Summary and conclusion, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 521-523, 1969.

Hypotheses proposed in papers presented in Section II of this symposium (Green, Scheynmann, Kushiro, Wyllie, Maxwell, Thayer, Jackson, and others) are summarized. All authors postulate direct partial melting for explaining variation of basalt magma types in time or space, and it is widely recognized that there is a complete gradation from ultramafic bodies of layered intrusions to the alpine type ultramafic bodies. The close association of alpine type with gabbroic rocks and basaltic lava flows indicates that they are genetically related to basaltic magmas. — VSN

Kuroda, P. K. *See* Manuel, Oliver K. 01953

09417 **Kushiro, I.** Clinopyroxene solid solutions formed by reactions between diopside and plagioclase at high pressures, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 179-191, illus., tables, 1969.

The subsolidus reactions between diopside and plagioclase have been studied on the joins diopside-albite, diopside-anorthite, and diopside-plagioclase ($An_{48.5}$) in the pressure range 8-36 kbar and in the temperature range 1,050-1400°C. Results are described and presented in tables and diagrams. The reactions obtained are consistent with the nature of the clinopyroxenes from quartz-bearing granulites and eclogites and may be useful in making preliminary estimates of the physical conditions of their formation. — *from* Author's abstract

09528 **Kushiro, I.** Discussion of the paper "The origin of basaltic and nephelinitic magmas in the Earth's mantle" by D. H. Green, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 427-436, illus., 1969.

Under anhydrous conditions magnesian olivine and not orthopyroxene is on the liquidus in primary basalt magmas after 'magma separation' within the upper mantle which probably consists of olivine-rich lherzolite. Experiments carried out by Green and Ringwood (1967) on some primary basalt compositions in the pressure range in which orthopyroxene is on the liquidus would not be applicable to fractional crystallization of primary basalt magmas after 'magma separation'. Under hydrous conditions, the field of orthopyroxene crystallization relative to that of magnesian olivine is reduced at higher pressures when bulk chemical composition is kept constant. The possibility that silica-saturated magmas are formed increases under hydrous conditions, even if water pressure is less than total pressure. Green's suggestion [ibid., p. 409-422] concerning generation of olivine nephelinite and olivine melilite nephelinite magmas under hydrous conditions would not be valid when bulk chemical composition is kept constant. — *from* Author's summary

Lahr, John C. *See* Sbar, Marc L. 01973

Lakin, Hubert W. *See* Shacklette, Hansford T. 01876

09285 **Lal, Ravindra K.** Paragenetic relations of aluminosilicates and gedrite from Fishtail Lake, Ontario, Canada: Lithos, v. 2, no. 2, p. 187-196, illus., tables, 1969.

Aluminosilicates occur in close association with gedrite in cordierite-bearing and cordierite-free schists and gneisses of this area. In cordierite-bearing rocks, sillimanite is incompatible with gedrite; it is either completely enclosed in cordierite, or in lithologically distinct layers from those in which gedrite occurs. In cordierite-free rocks, sillimanite and gedrite appear in close proximity, apparently because the lime content of the rock is sufficiently high so that it lies outside the cordierite composition field. Kyanite (andalusite) and gedrite are in close association as a result of breakdown of cordierite to kyanite and chlorite in a potash-deficient environment. — *from* Author's abstract

09506 **Lamb, George M.** Two new species of Foraminifera from the lower Mancos Shale (Upper Cretaceous) of the San Juan Basin, New Mexico: Cushman Found. Foram. Research Contr., v. 20, pt. 4, p. 143-144, illus., 1969.

Two new species of Foraminifera, *Ammomarginulina carlilensis* and *Haplophragmium arenatum*, were found in a stratigraphic section measured in Red Wash, the latter near the bottom of Red Wash in the lower portion of the Greenhorn Limestone, and the former from beds some 200 feet higher in the section, which seem to be equivalent to the Blue Hill Member of the Carlile Shale. — MCM

Landers, T. E. *See* Iyer, H. M. 01929

09488 **Lang, A. H.** The roles of the Geological Survey of Canada in former uranium programs: Canadian Mining and Metall. Bull., v. 62, no. 691, p. 1210-1218, illus., 1969.

A review of events that led to the discovery and development of past and present sources of uranium in Canada is presented in the belief that knowledge of approaches that were successful and unsuccessful could benefit present and future searches for additional ores. The history of Canadian discoveries is traced from the time when uranium deposits were scientific curiosities, through the periods when they were in demand. Most mines evolved from a series of events commonly occurring over long periods and forming complex 'chains' or 'patterns' in mineral exploration. [Discovery and development of uranium in the Athabasca and Elliot Lake areas is reviewed.] — *from* Author's abstract

09245 **Lange, Arthur L.; Farquhar, Roger P.** How computer graphics can be applied successfully to mineral exploration: Eng. and Mining Jour., v. 170, no. 6, p. 120-123, illus., table, 1969.

A number of atlases of magnetic curves have been published providing reference curves for geometric models, but even with their aid, interpretation can be slow and requires a trained interpreter. A system has been developed for rapid comparison of measured or processed data with curves representing response from basic geometric models having an unlimited range of parameters. The heart of this system is a cathode ray tube display of response curves generated as needed by a computer. An example of its use is finding a geometric model that could produce a certain hypothetical anomaly of total magnetic field from reduced airborne data. This program has been developed on a Scientific Data Systems 940 time-sharing computer, but is adaptable to others. — ESL

Langseth, M. G., Jr. *See* LePichon, X. 09571

09536 **Langseth, Marcus G., Jr.** The heat flow through the surface of the oceanic lithosphere [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 545, 1969.

LaRocque, Aurèle. *See* Cox, L. R. 09446

LaRocque, Aurèle. *See* Newell, N. D. 09447

09448 **LaRocque, Aurèle; Newell, N. D.; Weir, John; Haas, Fritz; Cox, L. R.** Systematic descriptions [subclass Palaeoheterodonta Newell, 1965], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N393-N489, illus., 1969.

Palaeoheterodonta (Middle Cambrian-Holocene) comprise the extinct Paleozoic marine actinodonts (Modiomorphoida Newell, n.ord.), the earliest known bivalves; the Trigonioida, an apparently homogeneous group of trigonal marine filibranchs; and the Unionoida, a large, probably polyphyletic group of nonmarine eulamellibranchs with equivalve, isomyarian, prismatonacreous shell. A total of 284 genera and 125 subgenera are described, under the superfamilies Modiomorphacea, Cycloconchacea, Trigonacea, Archanodontacea (new unionoid superfamily for Archanodontidae Weir, n.fam.), Anthracosiacea, and Unionacea. The family

Unionidae alone comprises 133 genera and 91 subgenera. The palaeoheterodonts lead in various lines to the Pteromorphia, Heterodonta, and possibly to other groups. — VMJ

LaRocque, Aurèle. *See* Branson, C. C. 09450

LaRocque, Aurèle. *See* Newell, N. B. 09451

LaRocque, Aurèle. *See* Chavan, André. 09497

09184 **Larrabee, D. M.** Corundum, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 336-337, 1969.

In Arizona corundum has been reported at an unknown source in northwestern Pinal County, which may be the deposit in the SE 1/4 sec. 12, T. 5 S., R. 5 E., that consists of crystalline corundum and associated rutile and quartz. These minerals form irregular masses, as much as several inches in diameter, in felsite dikes that cut granite. Other deposits have been reported in the Red Lake area, Mohave County, and the Papago Indian Reservation in Maricopa County. In general, ultramafic rocks and placers derived therefrom offer the best sources for prospecting for corundum. Any future production of abrasive quality corundum from Arizona appears practically nil; however, specimens of gem (largely semiprecious) quality might be found. — WLG

01943 **Larson, Peggy A.; Mudie, John D.; Hilde, Thomas W. C.; Larson, Roger L.** Sea-floor spreading in the Gulf of California? [abs.]: EOS, v. 51, no. 4, p. 330,1970.

Larson, Roger L. *See* Larson, Peggy A. 01943

01944 **Larson, Roger L.; Spiess, Fred N.** The American-Pacific plate boundary at the East Pacific Rise [abs.]: EOS, v. 51, no. 4, p. 329, 1970.

09538 **Laubscher, H.** Mountain building, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 551-563, illus., 1969.

Present-day oceans resemble eugeosynclines with shelf and continental slope showing miogeosynclinal features; this corroborates ocean-floor spreading models. The main orogenic period is characterized by contiguous and contemporaneous compression and distension, the latter associated with anomalously high heat flow, volcanism, metamorphism, and development of negative roots (oceanization). The ' new global tectonics' facilitates understanding of these paradoxical phenomena. Mountains are visualized as developing in sinks of global lithospheric movements by detachment of light crustal material, which is kept afloat and compressed while heavy bulk of the lithosphere drowns in the upper mantle. Significant modifications are introduced by the concepts that the lithosphere sinks under its own weight with attendant distension, local mass exchange, and increased heat transfer. — *from* Author's abstract

09309 **Laughlin, A. W.; Lovering, T. S.; Mauger, R. L.** Age of some Tertiary igneous rocks from the East Tintic district, Utah: Econ. Geology, v. 64, no. 8, p. 915-918, table, 1969.

Potassium-argon dating of samples from the East Tintic district, Utah, indicate a 15 m.y. period of volcanism and intrusion. This period commenced in mid-Oligocene time and continued into the Miocene. Mineralization apparently occurred within a short time span. — Authors' abstract

09310 **Laughlin, A. W.; Rehrig, W. A.; Mauger, R. L.** K-Ar chronology and sulfur and strontium isotope ratios at the Questa mine, New Mexico: Econ. Geology, v. 64, no. 8, p. 903-909, illus., table, 1969.

K-Ar age determinations indicate that magmatism and molybdenite mineralization are indistinguishable within an experimental error of 0.8 m.y. These ages of 22.3-23.5 m.y. fall in the mid-Tertiary pulse of magmatism recognized in the southwestern United States, and agree with dates reported on other molybdenum properties in the Rocky Mountain Province. Sulfur isotopic measures suggest that at least some of the gypsum is hypogene. The Sr-87/Sr-86 ratios in a whole-rock sample of the Mine Aplite yield an initial ratio of 0.7069 similar to previously reported ratios for volcanic and intrusive rocks in the western United States. — *from* Authors' abstract

01945 **Laul, J. C.; Pelly, I.; Lipschutz, M. E.** Thallium and other trace elements in primitive chondrites [abs.]: EOS, v. 51, no. 4, p. 341, 1970.

02184 **Lawson, B. L.; Cook, C. F.** A theoretical and laboratory evaluation of carbon logging — Pt. 2, Theoretical evaluation of oxygen interference, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. B1-B12, illus., tables, 1970.

Hydrocarbons bombarded with high energy neutrons emit 4.43 MeV gamma rays; detection of these rays in a noncarbonaceous reservoir would provide a direct means of identifying presence of hydrocarbons. However, there are interfering gamma rays created by neutrons inelastically scattering with omnipresent oxygen. A Monte Carlo procedure has been developed to calculate the uncollided steady-state 4.43 and 6.09 MeV gamma flux received by a detector immersed in an infinite reservoir with a 14 MeV neutron source; these data, combined with moments methods data, determine magnitude of interference. Data analysis indicates the problem is not severe enough to make direct detection of liquid hydrocarbons by nuclear means impractical; commercial saturations can be detected in sandstones having porosity of 15 percent; it is doubtful that residual hydrocarbons can be detected. A carbon logging tool will find its greatest application in workover operations, although it is not limited to this. — *from* Authors' abstract

02161 **Layer, D. B.; Sproule, J. C.** Robert William Landes, 1910-1969: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 120-121, portrait, 1970.

09321 **Lees, William R.** Post-depositional sulfurization of pyrrhotites from the Santa Eulalia Mine, Chihuahua, Mexico: Compass, v. 46, no. 2, p. 82-89, illus., table, 1969.

An examination has been made of several singly terminated, hexagonal pyrrhotite crystals from the Santa Eulalia Mine, Chihuahua, Mexico. Although of hexagonal external morphology and homogeneous except for some minute inclusions of pyrite, X-ray examination of the pyrrhotite has revealed a monoclinic internal structure. The samples were heated in sealed, evacuated silica tubes at 375°C for six minutes. X-ray analysis of the inverted pyrrhotite indicated an Fe content between 46.6 and 46.7 atomic percent. An X-ray analysis of coexisting sphalerite indicated that the pyrrhotite contained 47.9 atomic percent Fe at formation. — Author's abstract

09432 **Leger, Arthur R.** Stratigraphy of the Hopewell Formation of nonmarine redbeds, southeastern New Brunswick, Canada: Compass, v. 46, no. 2, p. 99-108, illus., 1969.

The Mississippian-Pennsylvanian Hopewell Formation is subdivided into three members, in ascending order: the Maringouin, Shepody, and Enrage. Near the source, the unit cannot be subdivided and is called the Undifferentiated Hopewell. The Maringouin Member is composed of coarse to fine detritus deposited in an intermontane basin under arid to semi-arid conditions. The remaining members are coarser fan material deposited, under similar conditions, farther out in the basin as uplift continued. The tectonic cycle of the area consists of marine transgression during the time of Windsor deposition, a period of tectonic quiescence, renewed uplift of the Caledonia Mts. beginning in late Windsor time and continuing through Mississippian Hopewell time, continued erosion of the highland, and a minor marine transgression in Pennsylvanian Hopewell time. — *from* Author's abstract

Leland, H. V. *See* Gross, D. L. 02118

Leland, Harry V. *See* Shimp, Neil F. 02204

09512 **LeMenestrel, J.** (compiler). Blackburn, Ontario-Quebec, geomorphology: Canada Geol. Survey Map 1264A, scale 1:25,000, text in French and English, sections, 1969.

Within the Blackburn map-area, the Ottawa River flows in a preglacial valley bounded on the north by the Precambrian upland and on the south by a north-facing cuesta of Paleozoic rocks. Between 10,000 and 11,500 yr B.P., the Champlain Sea inundated the area and deposited clay; subsequent isostatic uplift resulted in a progressive change from the marine environment to the fresh-water environment of the ancient Ottawa River. South of the cuesta is a channel of the former river now occupied by the Mer Bleue peat bog; adjacent terraces and three large islands are underlain by marine clay capped by a thin layer of fluvial sand; the channel was abandoned at least 7,700 yr ago. The highly thixotropic nature of the marine clay has resulted in numerous landslides. — MCM

02153 **Lenz, A. C.** Late Silurian brachiopods of Prongs Creek, northern Yukon: Jour. Paleontology, v. 44, no. 3, p. 480-500, illus., 1970.

Eighteen species of brachiopods, none previously recognized in western Canada, are described from the Late Silurian upper Road River Formation of Prongs Creek, Yukon Territory. This fauna is composed of 17 species from probable early Pridolian, and one species from early Middle Ludlovian age beds, which, because they are interbedded with graptolites, are rather precisely dated. New species described are all from the early Pridolian age beds and consist of *Aesopomum prongsi*, *Lanceomyonia brevicostata*, *Cryptatrypa fahraeusi*. Of considerable significance is the occurrence, in the Pridolian, of supposedly typical Devonian genera as *Aesopomum*, *Metaplasia*, and *Schizophoria*; this considerably extends downward the age range of these genera. — *from* Author's abstract

09283 **Leopold, Estella B.** Late Cenozoic palynology, [Chap.] 17 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 377-438, illus., tables, 1969.

Studies of late Cenozoic (Miocene-Pleistocene) palynology are reviewed. Emphasis is on extratropical floras of the Northern Hemisphere, which most of the available information concerns. Late Cenozoic floras can be compared with living plants on a detailed taxonomic basis; firmly based ecological inferences can be made. Neogene floras are generally less diverse than Paleogene floras, contain fewer extinct genera, and are more provincial. Subtropical elements widespread in northern midlatitudes retreated southward by late Miocene; in the Pliocene, widespread climatic deterioration limited the northern range of temperate plants; herbaceous pollen increased. Early Quaternary floras differ from Neogene in containing few if any Tertiary relict genera or extinct species. Effects of glaciations were complicated by many geographic factors. The main change in Quaternary vegetation of the Northern Hemisphere involved cliseral migrations of existing zones; few extinctions are recorded. — VMJ

09571 **LePichon, X.; Langseth, M. G., Jr.** Heat flow from the mid-ocean ridges and sea-floor spreading, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 319-344, illus., tables, 1969.

By normalizing the distance of observations of heat flow and of topographic elevation and slope from the midocean ridge axis in terms of spreading rate, a large amount of data from the ridge system can be used to derive the pattern of heat flow with great confidence. Analysis shows that the shape of the normalized anomaly of high heat flow over the ridge is independent of spreading rate; however, the amplitude of this anomaly over the fast-spreading Pacific ridges (2-6 cm per yr) is generally 0.5 μ cal/cm^2 sec larger than that over the Atlantic and Indian Ocean Ridges, spreading at 1-2 cm per yr. More than 60 percent of heat lost over ridges in excess of adjacent basin loss occurs in a narrow zone near the axis, corresponding to the ridge created in the last 6 m.y.; there is also a nearly linear relation between spreading rate and ridge topographic slope. A complex model of spreading such as a thin crustal layer moving over a broad stagnation zone could fit the observed data. — *from* Authors' abstract

01946 **LePichon, Xavier; Pautot, Guy; Martinais, Jacques; Sichler, Bertrand; Sibuet, Jean-Claude; Olivet, Jean-Louis; Bonnin, Jean.** Transform faults survey in North Atlantic [abs.]: EOS, v. 51, no. 4, p. 329, 1970.

02108 **LePichon, Xavier.** Correction to paper by Xavier LePichon, 'Sea-floor spreading and continental drift' [1968]: Jour. Geophys. Research, v. 75, no. 14, p. 2793, tables, 1970.

Errors in one of the tables given in the paper in question (ibid., v. 73, no. 12, p. 3661-3697, 1968) are corrected. Minor changes are required in another table also, on the India-Antarctic and India-Pacific poles of rotation, which result from using for the Africa-Antarctica pole an early determination based on a slightly different Antarctica-Pacific pole. These errors provide an opportunity to insist that the different computations of relative movements cannot be taken as precise estimates of the actual movements; the results of this paper should be taken with caution when comparing with actual geological and geophysical data. — DBV

09522 **LePichon, Xavier.** Models and structure of the oceanic crust, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 385-401, illus., 1969.

Geophysical measurements have mostly confirmed the validity of the standard structure of the oceanic crust as deduced from seismic refraction measurements in the early fifties. The relatively small degree of variability of the oceanic crust structure contrasts strongly with the comparatively large variability of the continental crust. Layer 1 consists of unconsolidated or semiconsolidated sediments no older than Lower Cretaceous. Layer 2 probably consists mainly of basalt, but may be locally covered by a layer of consolidated sediments of about Upper Jurassic age, or older. The results fit very well with the spreading floor hypothesis. There are no definitive arguments either for or against the serpentinite composition of layer 3 but an important fact is the progressive thickening of layer 3 away from the axial zone. The problem of the creation of the crust by the sea-floor spreading mechanism should be investigated within the framework of the mobile lithospheric plate concept. — Author's summary

09307 **Lessing, Peter.** Jordanite at Balmat, New York: Econ. Geology, v. 64, no. 8, p. 932, 1969.

A previously reported occurrence of jordanite (ibid., v. 54, p. 136-137, 1959) at the Balmat No. 2 mine has been confirmed by X-ray identification of material in new specimens. — WSW

09607 **Letteney, Cole D.** The anorthosite-norite-charnockite series of the Thirteenth Lake dome, south-central Adirondacks, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 329-342, illus., tables, 1968 [1969].

The Thirteenth Lake dome is cored by a metamorphosed complex of anorthosite-norite, which exhibits all compositional and textural gradations between the two lithologies. Structures and lithologic variations within the core of the dome seem to be unrelated to the general domal configuration of the overlying charnockite series. The charnockite and the anorthosite-norite are considered to be comagmatic. The magma is interpreted as having formed in two stages. The first caused separation of plagioclase from an anorthositic norite or diorite by filter pressing. The charnockite may have intruded the terrane during a second late stage of anorthosite-norite consolidation and may have been the product of differentiation of a subjacent magma. — *from* Author's abstract

Levinson, A. A. *See* Bayliss, P. 02157

09431 **Lewis, B.; Meyer, R.** Seysmicheskiye issledovaniya verkhney mantii vostochneye oz verkhnego [Seismic investigations of the upper mantle east [west] of Lake Superior], *in* Internat. Conf. Experts on Explosion Seismology, 1st. Leningrad, 1968,

Trans.: Kiev, U.S.S.R., Akad. Nauk Ukrain. SSR Inst. Geofiziki (Izdatel'stvo Naukova Dumka), p. 132-146, illus., 1969.

This is an abridged version in Russian, of the paper published in the Seismol. Soc. America Bull., v. 58, no. 2, p. 565-596, 1968; *see* Abstracts of North American Geology, September 1968. — DBV

Lewis, Brian T. R. *See* Kosalos, James G. 01942

Lewis, C. F. M. *See* Hobson, George D. 09352

09354 **Lewis, C. F. M.** Late Quaternary history of lake levels in the Huron and Erie basins, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 250-270, illus., table, 1969.

Sediments in several small lakes on Manitoulin Island document a history correlatable with the low level Lake Stanley, Nipissing transgression, and the post-Nipissing emergence in the Huron basin. The Nipissing Great Lakes reached maximum level about 5500 B.P. By 4700 B.P. the drainage transferred from North Bay outlet to southern outlets, continuing there for 800-900 years while uplift occurred to the north. Small basins within western Lake Erie, below postglacial clayey silt mud, contain much plant detritus of a marsh environment which ranged from 12,600 to 500 years B.P. Early Lake Erie appeared about 12,600 B. P. at 40 m below the present level which was short-lived as rebound raised the outlet at Buffalo. A sharp rise between 5000 and 3800 B.P. is correlated with the drainage transfer of Nipissing drainage through Erie. — *from* Author's abstract

02033 **Lewis, Richard Q., Sr.; Luft, Stanley J.** Geologic map of the Parnell quadrangle, Wayne County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-861, scale 1:24,000, section, text, 1970.

Small quantities of petroleum have been produced in the Parnell quadrangle for over 70 years from reef limestone in the lower part of the Fort Payne Formation and from Ordovician rocks below the Chattanooga Shale; future drilling might well be directed toward rocks of pre-Chattanooga age which are productive to the south and southeast. Limestone has been mined from a large quarry in St. Louis Limestone in the southeastern section and to a lesser degree from the upper part of the Ste. Genevieve Member and in the Monteagle Limestone; that in the latter is high-calcium, probably in part of chemical grade. Sandstone suitable for building stone could be quarried from the Hartselle Formation, and clay shale is available from the Pennington Formation. — MCM

01947 **Liebermann, Robert C.; Banerjee, Subir K.** Magnetoelastic interactions in hematite [abs.]: EOS, v. 51, no. 4, p. 418, 1970.

09265 **Ligner, J. J.; White, Natalie D.; Kister, L. R.; Moss, M. E.** Water resources, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 471-569, illus., tables, 1969.

Arizona is within the Colorado Plateaus province and the Basin and Range province; for purposes of water-resources investigations, it may be divided into three water provinces: Basin and Range lowlands, southern and southwestern; Plateau uplands, northern; and Central highland, transitional between the other two. Differing geographic and geologic environments are described to delineate water conditions and problems for each province. Surface water is appraised by river basin areas, and ground water by provinces, each of which is divided into areas; the Basin and Range province contains the largest supply. Quality of ground water varies locally; dissolved-solids content ranges from less than 500 to more than 100,000 ppm. — MCM

09328 **Limberg, Bruce E.** Statistical study of *Venericardia alticostata* (Conrad) from two outcrops of the Gosport Formation (Eocene), Alabama: Compass, v. 46, no. 4, p. 229-232, illus., 1969.

A statistical study of two samples of *Venericardia alticostata* (Conrad) from the Gosport Formation in Alabama was done to determine if an apparent size difference is taxonomically significant. Length, height, and width of 204 specimens were measured and Student's *t* values were calculated. The calculations revealed that there is, with greater than 99 percent confidence, a significant size difference between the samplings. However, although the author feels sure that operational biases were negligible, the high percentage of broken fossils, indicating a high energy depositional environment, might indicate that the sampling was naturally biased by sorting, thus influencing the statistical analysis and making an apparent difference seem real. — Author's abstract

09505 **Lindsley, D. H.; Muir, I. D.** Conditions of the ferrowollastonite-ferrohedenbergite inversion in the Skaergaard intrusion, East Greenland, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 193-201, illus., table, 1969.

Rocks from the late stages of fractionation of the Skaergaard intrusion contain ferrohedenbergites inverted from ferrowollastonite solid solutions and quartz inverted from tridymite. Experiments determining the temperature-pressure conditions of the hedenbergite-wollastonite solid-solution inversion for an analyzed Skaergaard ferrohedenbergite combined with published data on the quartz tridymite inversion show that the pressure was 600 ± 100 bars, and that the temperature range included the span 980-950°C during the late stages of crystallization of the Skaergaard intrusion. — *from* Authors' abstract

09580 **Lindsley, Donald H.** Melting relations of plagioclase at high pressures, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 39-46, illus., table, 1968 [1969].

At about 10 kilobars, anorthite begins to melt incongruently to corundum plus liquid. With increasing pressure, successively more sodic plagioclase melts incongruently until at 32 kb pure albite melts incongruently to jadeite plus liquid. No plagioclase is stable above approximately that pressure. In the range of binary melting, increasing pressure increases the temperature of the liquidus and solidus for a given composition. Throughout the range of binary melting, the plagioclase system gives no indication of a minimum in the melting curves. This fact permits rejection of the hypothesis that magmas rich in intermediate plagioclase components might form at great depths as a result of such a minimum. High pressure may be the factor in providing the mechanism for generating gabbroic anorthosite magmas at depths of 40 to 70 km. — *from* Author's abstract

Lineback, J. A. *See* Gross, D. L. 02118

Linehan, Daniel J. *See* Borbereky, Horst. 09515

Lines, Gregory C. *See* Bentley, Robert D. 01903

Lipschutz, M. E. *See* Jain, A. V. 01932

Lipschutz, M. E. *See* Laul, J. C. 01945

01948 **Lister, C. R. B.** A heat-flow profile across the Juan de Fuca Ridge near 47°N [abs.]: EOS, v. 51, no. 4, p. 317, 1970.

02192 **Lister, C. R. B.** Heat flow west of the Juan de Fuca ridge: Jour. Geophys. Research, v. 75, no. 14, p. 2648-2654, illus., table, 1970.

Fifteen new heat-flow measurements have been made as part of a general geophysical study west of the Juan de Fuca Ridge. All but one are within 16 km of latitude 47° N, and they form a profile from the crest of the ridge to a point out on the Tufts Abyssal Plain. Values decrease from 4μ cal per cm^2 sec at the crest of the ridge to 0.2 on the abyssal plain to the west, with the exception of one station 60 km west of the ridge where the heat flow is 10.9. Study of the possible causes of a high local value suggests that the real heat flow near the station is unlikely to be less than 7μ cal per

cm² sec, and therefore that the heat-flow distribution on the western flank of the ridge is abnormal. — Author's abstract

01949 **Liu, L. G.; Takahashi, T.; Bassett, W. A.** Isothermal compression of iron rich garnet at 25°C and the bulk modulus of the pyrope-almandite solid solutions [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

Loeblich, Alfred R., 3d. *See* Loeblich, Alfred R., Jr. 0209 6

02096 **Loeblich, Alfred R., Jr.; Loeblich, Alfred R., 3d.** Index to the genera, subgenera, and sections of the Pyrrhophyta, [Pt.] 4: Jour. Paleontology, v. 44, no. 3, p. 536-543, 1970.

Modern and fossil genera of the Pyrrhophyta [dinoflagellates] are catalogued, and an indication as to their validity under the International Code of Botanical Nomenclature or International Code of Zoological Nomenclature is given; 160 entries are included. The following new name is proposed: *Zygabikodinium nom. nov. pro Diplopeltopsis* Pavillard, 1913, *non* Hennings ex Hohnel, 1911. A new combination is made for the type species of *Cysta*. A bibliography of 104 items is included. — *from* Authors' abstract

02144 **Loeblich, Alfred R., Jr.; Tappan, Helen.** Annotated index and bibliography of the calcareous nannoplankton, [Pt.] 4: Jour. Paleontology, v. 44, no. 3, p. 558-574, 1970.

This annotated index of 538 entries includes modern and fossil calcareous nannoplankton taxa of all levels in addition to those appearing in the earlier index and supplements. New taxa and new combinations are cross referenced, and invalid and illegitimate taxa are so indicated. The bibliography includes 176 entries. — *from* Authors' abstract

02091 **Logan, Alan.** The new bivalve genus *Arctomyalina* from the Pennsylvanian of the Canadian Arctic Archipelago: Jour. Paleontology, v. 44, no. 3, p. 501-506, illus., table, 1970.

Arctomyalina, a new bivalve genus and its type species, *A. vokesi* n.sp., are described from the Nansen Formation (Morrowan-Atokan to lower Leonardian) at Otto Fiord, northwestern Ellesmere Island. It is assigned to the family Myalinidae because it is inequivalve and has a duplivincular ligament. Associated foraminifera suggest a Moscovian (Atokan) age for the part of the Nansen Formation containing *Arctomyalina*. — JWH

Longfield, R. L. *See* Woollard, G. P. 09141

Lorentzen, G. R. *See* Vogt, Peter R. 01993

Loux, P. C. *See* Foote, Richard Q. 01911

02083 **Love, J. D.; Good, John M.** Hydrocarbons in thermal areas, northwestern Wyoming: U.S. Geol. Survey Prof. Paper 644—B, p. B1-B23, illus., table, 1970.

Five natural occurrences of hydrocarbons in thermal areas lie in an arcuate southeastward- to eastward-trending area 70 miles long in northwestern Wyoming. The westernmost three are in Yellowstone National Park. All are associated with abundant sulfur and thermal springs and vents. Four are surrounded and underlain by volcanic rocks, which range in age from Eocene to Pleistocene. The fifth emerges from Paleozoic strata. The source of the hydrocarbons in four localities could be Paleozoic or Mesozoic sedimentary rocks that underlie the volcanics; one may be related to nonmarine algae. In at least two localities hot water and steam are involved in extraction and transport of the hydrocarbons. — JDL

Lovering, T. S. *See* Laughlin, A. W. 09309

Lowrie, W. *See* Fuller, Michael. 02183

Lowry, H. Michael. *See* Einwich, Anna M. 01908

Luft, Stanley J. *See* Lewis, Richard Q., Sr. 02033

01950 **Lum, Daniel.** Geohydrology of sewage effluent disposal in coastal limestone aquifers in Hawaii [abs.]: EOS, v. 51, no. 4, p. 284, 1970.

02099 **Lund, Richard.** A new technique for chemical preparation of fossils: Jour. Paleontology, v. 44, no. 3, p. 578, 1970.

Retrieval of small fossil vertebrate and invertebrate remains from shales, claystones and limestone residues has been difficult because of large amounts of residual silt and shale left by hitherto-used techniques. Treatment with Amine 220 and Methyl Amyl Alcohol reduced the volume of residual matrix from fresh water limestones by 60 to 99 percent in one treatment at room temperature. A fume hood is necessary. — FCW

02150 **Lundberg, John G.; Case, Gerard R.** A new catfish from the Eocene Green River Formation, Wyoming: Jour. Paleontology, v. 44, no. 3, p. 451-457, illus., tables, 1970.

A new catfish, *Hypsidoris farsonensis* [n.gen., n. sp.] from the Green River Formation [southwestern Wyoming] is described. The trenchant features of this fish include six or seven pelvic rays, exceptionally long fin spines, a pair of prevomerine tooth patches, reduced development of the rib on the fifth vertebra, and lack of jaw muscle origin on the skull roof. Two derived character states within the siluriform fishes are the presence of more than six pelvic fin rays, and the lack of an ossified ischiac process on the basipterygium. These conditions, found in both modern ictalurids and a number of North American fossil catfishes, are taken as evidence for a close cladistic relationship between these two groups. — Authors' abstract

09579 **Luth, W. C.; Simmons, Gene.** Melting relations in natural anorthosite, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 31-37, illus., tables, 1968 [1969].

The temperature at which a silicate melt first appears in the presence of an aqueous vapor phase has been determined for the Marcy anorthosite. The experimental values are 985 ± 10°C at 1 kb, 935 ± 10°C at 2 kb, 815 ± 10°C at 5 kb. These values are in excellent agreement with predictions based on the available data in synthetic systems. — Authors' abstract

Luyendyk, Bruce P. *See* Phillips, J. D. 01967

09563 **Lyon, R. J. P.; Patterson, J.** Airborne geological mapping using infrared emission spectra, [Pt.] 1, *in* Symposium on remote sensing of environment, 6th Internat., Ann Arbor, Mich., 1969, Proc., V. 1: Ann Arbor, Mich., Univ. Michigan, Willow Run Labs., p. 527-552, illus., 1969.

Spectra collected over quartz monzonitic, andesitic, and basaltic volcanic rocks and their soils in the Sonora Pass, Calif., area, enable these materials to be discriminated and their contacts mapped, while flying at 180 knots and 2000-9000 feet above the terrane. The spectra in the 6.7-13.4 micron range are collected at 6 per sec and tape recorded. The integrated ground-swath of each spectrum is 14 feet wide by 40 feet long, at 2000 feet. Results from 3 flight tests show the method can discriminate materials with around 90 percent accuracy, but will define contacts to within one spectrum (150 msec × aircraft speed), using the BMD07M stepwise discriminant program. Problems involve manner of selection of 'training' spectra in relation to degree of homogeneity of the target. The technique appears suitable for differentiating subspecies within mappable units, e.g. in the monzonite. — *from* Author's abstract

MacDonald, G. J. F. *See* Knopoff, L. 09568

Machesky, L. F. *See* Woollard, G. P. 09141

09483 **MacIsaac, W. F.** Copper Mountain geology at Gaspé Copper Mines, Limited: Canadian Mining and Metall. Bull., v. 62, no. 688, p. 829-836, illus., 1969.

The large low-grade Copper Mountain deposit is located in the northern portion of the Gaspé Copper Mines property. It is approximately 1 mile north of the Needle Mountain deposit. The orebody outlined to date lies in the top 1,000 feet of the Grande Grève formation. Chalcopyrite occurs in association with pyrite and quartz in small veinlets and numerous fractures. The deposit is immediately adjacent and parallel to a quartz-feldspar dike and may be associated with a nearby porphyry stock. Stratigraphy, alteration and structure appear to have played an important role in ore deposition. — Authors' abstract

09305 **MacLean, Wallace H.** Liquidus phase relations in the FeS-FeO-Fe_3O_4-SiO_2 system, and their application in geology: Econ. Geology, v. 64, no. 8, p. 865-884, illus., tables, 1969.

"Iron-silicate liquid coexists with iron-sulfide liquid throughout a large volume of the experimental system. Solubility of FeS in iron-silicate liquid is maximum when in equilibrium with iron and decreases with increasing fugacity of oxygen." Insofar as this system typifies the behavior of sulfur in mafic and ultramafic rocks, it indicates that oxidation state is the principal factor controlling the temperature at which a sulfide liquid would be generated in the mantle and controlling the conditions under which it would separate from a silicate magma at various levels in the crust. Ore deposits could form by intrusion of sulfide liquids or rapid oxidation of mafic magma. — WSW

02088 **MacLean, William P., 3d.** The braincase of *Labidosaurikos* (a Permian captorhinomorph reptile): Jour. Paleontology, v. 44, no. 3, p. 458-463, illus., 1970.

The braincase of a single specimen of *Labidosaurikos meachami* is described [from Early Permian Garber-Hennessey transition beds, Logan County, Okla.]. The most important feature of this specimen is that the sphenethmoid region is extensively ossified, giving the braincase a labyrinthodont aspect. The captorhinomorph braincase must now be considered more of a labyrinthodont-modern reptile intermediate structure rather than a generalized reptile prototype, as the braincase of *Captorhinus* would suggest. — Author's abstract

02087 **Macomber, R. W.** Articulate brachiopods from the upper Bighorn Formation (Late Ordovician) of Wyoming: Jour. Paleontology, v. 44, no. 3, p. 416-450, illus., tables, 1970.

The upper Bighorn Formation in the Bighorn Mountains is correlated by its articulate brachiopod fauna, and by lithology, with the Stony Mountain Formation of Manitoba and the upper Maquoketa Formation of Iowa; the brachiopods are also similar to those in the Red River Formation (Manitoba), the Montoya Group (Texas), the Upper Ordovician of Anticosti Island, the Ordovician of Baffin Island, and the Fish Haven Dolomite (Idaho). Recent conodont studies indicate a Maysvillian, not Richmondian, age for the Stony Mountain and upper Bighorn. A broad species concept is employed; 17 species in 14 genera are described; none of the taxa are new. — REG

02155 **Macqueen, Roger W.; Sandberg, Charles A.** Stratigraphy, age and interregional correlation of the Exshaw Formation, Alberta Rocky Mountains: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 32-66, illus., tables, 1970.

The Exshaw consists of a lower black shale unit and an upper siltstone unit separated by a gradational contact. At the type section, the upper contact is revised upward to include all the unbroken sequence of calcareous siltstone. At the outcrop, the Exshaw unconformably overlies the Devonian Palliser Formation, and is overlain by basal shales of the Mississippian Banff Formation. Material in the black shale unit was probably derived from soils and deposited in shallow-marine, euxinic lagoons; the siltstone unit was deposited in a regressive, marginal-marine environment. The Exshaw is a correlative of lower members of the Bakken in the subsurface of Alberta

and Saskatchewan, and of the Sappington Member of the Three Forks in Montana. Conodont evidence shows the Exshaw to be Devonian and Mississippian, with the systemic boundary near the middle of the black shale unit. — *from* Authors' abstract

Madison, R. J. *See* Norvitch, R. F. 09516

01951 **Magorian, Thomas R.** Characteristic overland flow length [abs.]: EOS, v. 51, no. 4, p. 278, 1970.

02114 **Maher, J. C.; Trollman, W. M.** (compilers). Geological literature on the north slope of Alaska: Tulsa, Okla., Am. Assoc. Petroleum Geologists, 133 p., illus., 1970.

This compilation includes most of the geological literature on the Arctic region north of lat 68° N. in Alaska published prior to November 1, 1969. The area covered by the cited literature encompasses (from south to north) three broad, subparallel physiographic provinces: Brooks Range, including the DeLong Mountains; Arctic Foothills; and Arctic Coastal Plain. Naval Petroleum Reserve No. 4 in the latter two occupies about one-third of the area. Special effort was made to find references pertaining to petroleum geology, which includes the fields of stratigraphy, paleontology, structure, and geophysics; no attempt was made to include all articles dealing primarily with mining operations. The index is meant to serve only as a guide in library search; only the title of the reference was considered in indexing. — MCM

01952 **Malahoff, Alexander; Burns, R.** Gravity anomalies across the fracture zones of the northeastern Pacific Ocean [abs.]: EOS, v. 51, no. 4, p. 318, 1970.

Malcuit, Robert J. *See* Kohout, Douglas L. 09326

Malone, Philip G. *See* Towe, K. M. 02131

Mamet, Bernard L. *See* Armstrong, Augustus K. 02072

09355 **Mandelbaum, Hugo.** Analysis of sediment cores from Big Muscamoot Bay and Goose Bay in the St. Clair River Delta, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 271-299, illus., tables, 1969.

Grain size analysis of cores from this delta shows a great variability. A defined variability index has a lognormal distribution and is directly correlated to mean grain size of the sediment. Openess of the sedimentation area increases both mean grain size and variability. Higher order trend surfaces of sediment parameters reveal strong trends in the direction of the bay axes but inconsistent trends across the bays. A singular area is the boundary between the open Outer Muscamoot Bay and the inner Muscamoot Bay. The amount of very coarse grains is surprisingly large in the Outer Muscamoot Bay, more than 1.5 percent by weight. The origin of this coarse fraction is problematic; data point to stability since the beginning of deltaic sedimentation 12,000 years ago. — *from* Author's abstract

Manheim, Frank T. *See* Sayles, Fred L. 01972

Manuel, O. K. *See* Wright, Robert J. 02003

Manuel, O. K. *See* Alexander, E. C., Jr. 02066

01953 **Manuel, Oliver K.; Kuroda, P. K.** Mass fractionation and isotope anomalies in neon and xenon [abs.]: EOS, v. 51, no. 4, p. 339, 1970.

Marleau, R. *See* Dugas, Jean. 09484

09291 **Marsh, Owen T.** Geologic map of the Palmyra quadrangle, Tennessee: Tennessee Div. Geology Geol. Map GM 302-NW, scale 1:24,000, separate text, 1969.

The accompanying text, "Mineral resources summary of the Palmyra quadrangle, Tennessee," by C. R. Sykes is cited separately. — MCM

Martin, L. *See* Gleeson, Christopher F. 09548

09211 **Martin, William C.** Fossil flora of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 101-106, 1969.

The fossil flora (except for oak leaves) represented by leaves, stems, and fruit compressions, mostly leaf impressions, is illustrated and discussed. Some are unidentifiable even to family level, and certain fragments are tentatively referred to particular families. Taxonomically, the Rita Blanca material is not old enough for sweeping changes to have occurred in the taxonomic relationships of species entities, but old enough for minor changes to have been possible. Therefore, the material is compared with extant forms, and present-day nomenclature is followed in all instances. — *from* Author's introduction

Martinais, Jacques. *See* LePichon, Xavier. 01946

02147 **Mathewson, Christopher C.** Submarine canyons and the shelf along the north coast of Molokai Island, Hawaiian Ridge: Pacific Sci., v. 24, no. 2, p. 235-244, illus., 1970.

The north insular shelf of Molokai is a smooth plain, gently dipping seaward, with three slight steps; the shelf break occurs near the 500 ft isobath. Off East Molokai Volcano the shelf is cut by 11 submarine canyons; along West Molokai it is unbroken except for one canyon. About half the canyons have bowl-shaped heads, the remainder V-shaped heads; canyons originate about 1 mile offshore. Seismic reflection data show the insular shelf is covered by a thin veneer of sediments thickening seaward. The veneer is underlain by a series of reflectors, the deepest 0.05 sec one mi from shore and 0.25 sec three mi from shore. The Molokai submarine canyons appear to have originated from subaerial erosion, followed by island subsidence with sediment deposition on the shelf and transport in the canyons. The geomorphology of the north slope of Molokai appears to have developed through erosion and deposition, operating upon a subsiding volcanic island. — *from* Author's abstract

Matteson, Charles. *See* Gedney, Larry. 02140

Matthews, Barry. *See* Bartley, David D. 09543

09620 **Matthews, D. H.** Model study of the magnetic anomaly pattern across the Mid-Atlantic Ridge at 45° North, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 353-358, illus., 1969.

The effects upon the calculated magnetic anomaly profile of a scatter of dike injections about the center line of the ridge has been investigated utilizing the observed reversal time scale. Results suggest that a scatter with a standard deviation of 5 km from the center line can account for the lack of symmetry of the observed magnetic profiles. — Authors abstract

Mauger, R. L. *See* Laughlin, A. W. 09309

Mauger, R. L. *See* Laughlin, A. W. 09310

Mayeda, Toshiko. *See* Onuma, Naoki. 01963

09445 **McAlester, A. L.; Keen, A. Myra; Puri, H. S.** Systematic descriptions[subclass Palaeotaxodonta Korobkov, 1954], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N227-N241, illus., 1969.

Palaeotaxodonta (Ordovician-Holocene) comprise a single order, Nuculoida, a homogeneous group characterized by a primitive taxodont hinge and, in living forms, protobranchiate gills. Shell is equivalve, with closed margins, isomyarian, nacreous or crossed lamellar; ligament generally amphidetic, external; foot grooved and reptant, not byssiferous in adults. All are detritus feeders, with both epifaunal and in-

faunal representatives. Sixty-three genera and 40 subgenera are described under three superfamilies: Ctenodontacea, Ordovician-Carboniferous, characterized by equilateral shell; Nuculacea and Nuculanacea, Ordovician-Holocene, with shell posterior truncate and elongate, respectively. Although nuculoids are considered the most primitive living bivalves, there is no direct evidence that they gave rise to other, radically different morphological types. — VMJ

02149 **McAlester, A. Lee.** Animal extinctions, oxygen consumption, and atmospheric history: Jour. Paleontology, v. 44, no. 3, p. 405-409, illus., 1970.

Past susceptibility to family-level extinctions within major taxa of fossil animals shows a close positive correlation ($r = 0.905$) with oxygen uptake in Recent representatives of the same taxa. Taxa that have had high extinction rates have high present-day rates of oxygen consumption; taxa that have had unusually stable histories have very low rates. This correlation shows that periodic episodes of animal extinction were caused by environmental stresses that selectively eliminated animals having high rates of energy utilization. Past variation in the concentration of atmospheric oxygen appears to be among the most probable environmental changes that could be expected to produce such an effect. — Author's abstract

09313 **McAnulty, William N.** Evaluation of fluorspar deposits [abs.]: Econ. Geology, v. 64, no. 8, p. 938, 1969.

McCaleb, J. A. *See* Wayhan, D. A., 09386

McCann, S. B. *See* Owens, E. H. 02164

McCloughan, C. H. *See* Kanasewich, E. R. 09574

McClure, D. V. *See* Weaver, D. W. 09398

02037 **McConaghy, James A.** Reconnaissance of water resources in the Haines-Port Chilkoot area, Alaska: U.S. Geol. Survey Circ. 626, 16 p., illus., tables, 1970.

Dense bedrock in the Haines-Port Chilkoot area is not a good source of ground water. Surficial deposits, which constitute the best aquifers, are composed of sand, gravel, and cobbles interbedded with clay, silt, and other fine-grained sediments. Present water supply for both communities, mainly surface water, is adequate although shortages occur during dry periods in summer or cold periods in winter. All ground water near Haines is derived locally and directly related to precipitation; areal extent and storage capacity of all aquifers are small. Large quantities (to 500 gpm) are probably available from surficial deposits in only a few areas. The most obvious source of fresh water is the Chilkat River; however, it contains glacial flour which is difficult to remove. It is concluded that ground water will be the best source of additional water. — MCM

McDougall, D. J. *See* Douglas, G. 02121

02224 **McGrath, P. H.** Magnetic investigations of the Charlotte and Pokiok intrusions, southern New Brunswick: Geol. Assoc. Canada Proc., v. 21, p. 25-32, illus., 1970.

In situ magnetic susceptibility measurements were obtained on one hundred and ninety-nine outcrops in southern New Brunswick during the 1968 field season. Also, sixty 1.25 inch-diameter oriented drill cores were collected for natural remanent magnetization and Konigsberger ratio determinations. The data indicate that (1) magnetic anomalies in southern New Brunswick are primarily caused by variations in rock susceptibility, (2) the Pokiok and Charlotte intrusions can be subdivided into phases which reflect either the multiple intrusion or the partial metasomatism of these two batholiths, and (3) pyritiferous sedimentary rocks become magnetic in the vicinity of the Pokiok intrusion. This latter effect is probably the result of a pyrite pyrrhotite magnetite transition caused by thermal metamorphism during intrusion of the batholith. — Author's abstract

02198 **McKee, E. H.; Noble, D. C.; Silberman, M. L.** Middle Miocene hiatus in volcanic activity in the Great Basin area of the western United States: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 93-96, illus., 1970.

A summary of potassium-argon dates shows that a high level of igneous activity in the Great Basin and adjacent regions during middle Tertiary time (40 to 20 m.y. ago) was followed by a period of relative quiescence in middle Miocene time that lasted for several million years (from 20 to 17 m.y. ago). Volcanism resumed 16 m.y. ago mainly at the margins of the region and has continued to the present. — Authors' abstract

09557 **McKee, Edwin D.; Gutschick, Raymond C.** Interpretation of environments, Chap. 14 *in* History of the Redwall Limestone of northern Arizona: Geol. Soc. America Mem. 114, p. 553-570, illus., tables, 1969.

Textural varieties of the Redwall Limestone include aphanitic limestone from lime mud; oolitic limestone from an environment of moderate energy potential; peloidal limestone, a product of moderate to strong turbulence bringing particles of varying sizes into a muddy matrix; bioclastic limestone from deposits of considerable energy; and limestone conglomerate, a product of extreme turbulence. Several cycles are recognized in the limestones, reflecting a series of stages of environmental change. Chert and dolomite are present as replacement material, and detrital sediments are very rare. Numerous solution features are present, and large-scale cross-lamination occurs. Certain factors of the environment can be delimited from an analysis of the fauna. — HRC

McKey, J. R. *See* Weaver, D. W. 09398

09226 **McKnight, John F.** Geologic map of Bofecillos Mountains area, trans-Pecos Texas: Texas Univ. Austin Bur. Econ. Geology Geol. Quad. Map 37, scale 1:48,000, sections, separate text, 1969.

The Bofecillos Mts. area contains a Tertiary volcanic vent and a varied sequence of lava flows, tuff, and associated conglomerate, sandstone, and mudrock; after cessation of most volcanic activity, the area was block faulted and later dissected into a rugged high-standing terrain. About 2,200 feet of Cretaceous strata are exposed in erosional lowlands, domes, and horsts where Tertiary volcanic rocks have been removed. Subdivision of Tertiary formations and members records local complexities in stratigraphy. Quaternary pediment and terrace gravels are in several bolsons; alluvium of the Rio Grande valley is either channel gravel or flood-plain deposits. Most of the area is underlain at depth by folded and faulted Paleozoic strata of the NE-trending frontal zone of the Ouachita structural belt; desert landforms are characteristic of the region; Laramide deformation produced only gentle open folds. Economic resources are mercury, ground water, and possibly bentonitic clay, perlite, and petroleum. — MCM

McKown, D. M. *See* Ehmann, W. D. 02019

McManus, Dean A. *See* Holmes, Mark L. 01925

09249 **Medina Rivero, Flavio.** Las aguas artesianas de Hedionda (Yoliatl), Municipio de Villa de Ramos, S.L.P. [Artesian waters of Hedionda (Yoliatl), Municipality of Villa de Ramos, San Luis Potosí]: Geología y Metalurgia, v. 4, no. 29, p. 5-27, illus., tables, 1969.

In the vicinity of Hedionda (Yoliatl), 30 km north of Salinas in the western part of San Luis Potosí State, a brief hydrogeological study was made of the artesian waters from a deep well belonging to the Commission of Building and Sanitary Engineering of the Secretariat of Health and Assistance. A comparison is made of chemical analyses of the artesian water, ground water and water from local pumps. — *from* Author's abstract, EH

Meisler, Harold. *See* Becher, Albert E. 02221

09562 **Mellett, James S.** Carnassial rotation in a fossil carnivore: Am. Midland Naturalist, v. 82, no. 1, p. 287-289, illus., 1969.

Medial rotation of the upper carnassial teeth along the proximodistal axis occurred in the genus *Hyaenodon* (Mammalia, Deltatheridia) in order to maintain tight occlusal contact between upper and lower shearing teeth. Heavy wear on the shearing faces of M^{1-2}, combined with limited ectental motion of the lower jaw, appear to be factors that made the rotation necessary. The condition has not been observed in any fissipede carnivore. — Author's abstract

Melson, William G. *See* Thompson, Geoffrey. 02025

Menard, H. W. *See* Francheteau, Jean. 02197

09135 **Meneley, W. A.** Special problems of topography and geologic characteristics, *in* Groundwater-streamflow systems — Canadian Natl. Comm. Hydrol. Decade and Laval Univ., Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, p. 33-36, discussion [1969?].

Natural ground-water flow systems are in dynamic equilibrium with the recharge input; developed systems are not. Permeability of a particular flow path will be governed by that of the least permeable segment. Rate of flow in real ground-water systems can be measured only if the three-dimensional permeability can be measured. Ground-water systems are subject to time-transient changes in amount and direction of flow. If ground-water circulation tends to increase permeability, as by solution, water-table relief will decrease with time; if circulation tends to decrease permeability, as by cementation, relief on the water table will tend to increase. Proper management of ground water requires the capability of predicting the effect of a particular scheme of development upon the hydrogeologic environment. Examples of drawdown from pumping in aquifers in Saskatchewan and Alberta are given. Further research is urgently required. — ESL

09621 **Menyaylov, I. A.** Fumarolnyye gazy piroklasticheskikh potokov vulkanov Bezymyannogo i Katmai [Fumarole gases of pyroclastic flows of Bezymyannyy and Katmai volcanoes], *in* Vulkany i izverzheniya: Moscow, Izdatelstvo Nauka, p. 78-81, 1969.

Analysis of fumarolic gases in pyroclastic flows shows that the same type of source supplies the fumaroles of both Katmai and Bezymyannyy volcanoes with gases which were entrapped in the flows at the time of eruption. Varied composition of fumarole gases at the initial and final stages of eruption is explained by uneven distribution of volatile matter in magma in the volcanic chimney. — *from* Authors abstract

01954 **Merkel, Richard H.** The mapping of ground water by placing a current source in a drill hole [abs.]: EOS, v. 51, no. 4, p. 285, 1970.

09491 **Metter, Dean E.; Pauken, Robert J.** An analysis of the reduction of gene flow in *Ascaphus truei* in the northwest U.S. since the Pleistocene: Copeia 1969, no. 2, p. 301-307, illus., tables, 1969.

Ascaphus truei shows a disjunct distribution in the northwestern United States and appears to have low gene flow between adjacent populations. D^2 values of morphological characters of 17 populations of the species reflect progressive reduction of gene flow since Pleistocene. Geologic evidence for changing environments correlates closely with this indication of contracting range. The range of *Ascaphus* appears to have been almost continuous across Washington, Oregon, northern Idaho, and western Montana during late Pleistocene with much gene flow occurring; post-Pleistocene environmental changes have resulted in a progressively contracted range. The now semi-desert, high area of south-central Oregon was apparently the last avenue of gene flow for this frog between the Cascade Mts. and inland populations. The indicated pattern of gene flow may be applicable to other vertebrates which show discontinuous distributions in the northwest U.S. — *from* Authors' abstract

Meyer, G. L. *See* Weaver, D. W. 09400

Meyer, R. *See* Lewis, B. 09431

Meyer, Robert P. *See* Anzoleaga, Rodolfo. 01907

Meyer, Robert P. *See* Kosalos, James G. 01942

Meyer, Robert P. *See* Ocola, Leonidas C. 01961

09452 **Meyerhoff, A. A.; Meyerhoff, H. A.** Buena noticia — Son promisorias las Lomas Sigsbee del Golfo de México [with English abs.]: Petróleo Interamericano, v. 27, no. 4, p. 67-68, illus., 1969.

The newly acquired information revealing that the Sigsbee Knolls are diapirs, and that they have shows of oil and gas, has made the deep Gulf of Mexico a place to consider for accumulation of hydrocarbons. — Authors' abstract

Meyerhoff, H. A. *See* Meyerhoff, A. A. 09452

09263 **Michener, C. E.** Summary of the symposium on magmatic ore deposits, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 366, 1969.

New ideas presented in this symposium include: importance of oxygen fugacity in studying reactions in complex system, concept of sublayer of ore-rock which has a common origin with Sudbury norite, use of charts to show progressive enrichment or depletion of composition in magma with time, extrusive origin of Bushveld complex, advance in understanding of Cu-Ni-S and Cu-Ni-S-Fe systems, and in Precambrian areas remobilization and metamorphism have combined in places to produce cross-cutting relations that are not real (Creighton granite-Norite contact relations at Sudbury). — VSN

Middel, Ursula. *See* Bender, Michael. 01893

Mikulich, Matthew J. *See* Smith, Robert B. 01982

Miller, D. K. *See* Wright, Robert J. 02003

02078 **Miller, D. N., Jr.** Thomas W. Todd (1927-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 808-809, portrait, 1970.

01955 **Miller, Donald K.; Reynolds, M. A.; Sakamoto, Koh.** The isotopic composition of xenon and krypton in ordinary chondrites [abs.]: EOS, v. 51, no. 4, p. 340, 1970.

02107 **Miller, Howard S.** Dollars for research — Science and its patrons in nineteenth-century America: Seattle, Wash., and London, England, Univ. Washington Press, 258 p., 1970.

Save for the unremitting efforts of 19th century scientists, there were no general principles governing private philanthropy for scientific purposes. Public appropriations outweighed private donations, but qualitatively, 19th century financing from the private sector improved the tone and tempo of American scientific work. Chapters in this history are: a bounty for research (Smithsonian Institution), works of creation (astronomical observatories), the personal equation (botany, Asa Gray and Agassiz), science and the community interest (establishment of scientific schools), the new astronomy, endowment of research, fossils and free enterprisers, science and the higher learning, a university in which there are no students (Carnegie libraries), and a plea for pure science. Extensive notes (48 pages), an essay on source material, and a subject index are appended. — MCM

Miller, Robert A. *See* Kingston, Gary A. 02023

09325 **Miller, Wesley L.** Field geology via wheelchair: Compass, v. 46, no. 3, p. 181-184, illus., 1969.

Although field geology requires a great deal of mobility, a geologist who is confined to a wheel chair need not necessarily be restricted to the laboratory. Through proper choice of equipment, field procedure, and a certain amount of improvising, the handicapped geologist can be a useful member of a field party in almost any terrain. — Author's introduction

09470 **Milne, V. G.** Progress report on a field study of the Manitouwadge-area ore deposits [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 209, 1969.

02138 **Mizutani, H.; Hamano, Y.; Ida, Y.; Akimoto, S.** Compressional-wave velocities of fayalite, Fe_2SiO spinel, and coesite: Jour. Geophys. Research, v. 75, no. 14, p. 2741-2747, illus., tables, 1970.

Compressional-wave velocities of fayalite, Fe_2SiO spinel, α quartz, and coesite were determined by the pulse-transmission method at pressures to 6 kb and room temperature. The compression-wave velocity at 4 kb of polycrystalline fayalite is 6.7 ± 0.1 kmps, whereas that of polycrystalline Fe_2SiO spinel is 8.0 ± 0.1 kmps. The velocity jump at the olivine-spinel transition is 19 percent, whereas the density jump is 10 percent. The compressional-wave velocity of $(Mg,Fe)_2SiO$ olivine varies linearly with the FeO/(FeO + MgO) ratio of the samples. The compressional-wave velocity of the spinel polymorph of Mg_2SiO is 10.3 kmps. The compressional-wave velocities at 4 kb of polycrystalline α quartz and coesite are 6.2 ± 0.1 kmps and 7.6 ± 0.1 kmps, respectively. — *from* Authors' abstract

Modzeleski, V. E. *See* Krouse, H. R. 02020

Moh, G. H. *See* Kullerud, G. 09223

Monahan, Edward C. *See* Woodrow, Donald L. 09439

09412 **Moore, Paul B.** Joesmithite — A novel amphibole crystal chemistry, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 111-115, illus., tables, 1969.

Joesmithite is a beryllo-silicate clinoamphibole. One out of four tetrahedra in the asymmetric unit is occupied by beryllium, at the cross-linked site in one of the pyroxene chain subunits. The A site is not centered but displaced 0.6 A along the two-fold roter and toward the beryllate tetrahedron. It is suggested that a coupled relationship exists between A′ (the off-centered A site) and Be, a condition ensuring reasonable charge balance around their mutual anions. The A′ and Be atomic species lower the symmetry of the crystal. Though joesmithite is topologically akin to the C-centered clinoamphibole, its chemical contents are somewhat different. — *from* Author's abstract

Moore, R. T. *See* VanAlstine, R. E. 09187

09499 **Moore, Raymond C.** Omission — Treatise on invertebrate paleontology, Pt. N [Mollusca 6, Bivalvia, V. 2, 1969]: Jour. Paleontology, v. 44, no. 2, p. 402, 1970.

Through oversight, page N952, containing the end of the index, was omitted; index entries *Xylophaginidae* through *Zyrphaea* are supplied herein. — VMJ

09163 **Moore, Richard T.** Beryllium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 102-113, illus., table, 1969.

Occurrences of beryllium have been reported from more than 80 localities in Arizona; a brief description of each is given in tabular form. The minerals have been found in three principal types of deposits (in order of present decreasing importance)—pegmatite, vein, and disseminated deposits in tactites—in the southern and western sections of the state. — MCM

09165 **Moore, Richard T.** Cobalt and nickel, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 114-117, illus., 1969.

No commercial production of either cobalt or nickel has been made in Arizona; however, minerals containing these metals have been reported from several localities. The most promising occurrence is the large tonnage of cobaltiferous arsenopyrite at the Old Dick Mine but this deposit apparently could be exploited for cobalt only under economic conditions more favorable than at present. — WLG

09167 **Moore, Richard T.** Gold, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 156-167, illus., tables, 1969.

During the past several years Arizona has produced between 130,000 and 150,000 ounces of gold per year, the greater percentage a byproduct of copper mining. The lode deposits in Arizona can be grouped into four main categories: hydrothermal gold-quartz veins, siliceous fissure veins containing gold-bearing base-metal sulfides, massive sulfide replacement deposits carrying gold as an accessory, and gold-bearing disseminated copper deposits. As long as the State's copper production remains at its current level, gold production should continue at least at present levels. — WLG

09168 **Moore, Richard T.** Lead and zinc, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 182-205, illus., table, 1969.

The greater proportion of the known lead and zinc occurrences in Arizona are in the Jerome-Wickenburg area, which is part of a broad belt of deposits through Cochise, Yavapai, and Mohave Counties. Within this belt are two notable concentrations of deposits: in central Yavapai County, a large cluster of lead-bearing fissure veins cuts Precambrian granitic and metamorphosed sedimentary and volcanic rocks, and several zinc-lead replacement bodies occur in the metamorphic units; and those centered in Cochise, Santa Cruz, and eastern Pima Counties consist mainly of replacement deposits in Paleozoic and Mesozoic sedimentary rocks. Brief geologic descriptions of each of the 118 mining districts recognized as producing either lead, or lead and zinc are tabulated. — WLG

09180 **Moore, Richard T.** Zirconium and hafnium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 296-299, illus., 1969.

Zircon is found in minor amounts at many localities in Arizona, and black-sand placer deposits in the Kirkland district, Yavapai County, are reported to contain the mineral in potentially commercial quantities. These placer deposits are in Holocene alluvial material made up largely of sand, clay, and boulders derived from granite in the nearby Sierra Prieta; undoubtedly the zircon was originally present in the granite as an accessory mineral. Areas considered favorable for placer concentrations because of the occurrence of zircon as an accessory mineral in adjacent granitic or metamorphic rocks are listed and described briefly. — WLG

09193 **Moore, Richard T.** Mica, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 398-403, illus., table, 1969.

Arizona mica deposits fall into three geologic categories: mica schist, including segregations of flake mica in gneissic rocks; pegmatite; and sericite in hydrothermally altered veins and wall rock. According to past production the most important mica schist type is that which includes the Buckeye Hills and Quartzite deposits. Some scrap and essentially all of the sheet mica has been obtained from pegmatite deposits; this type is exemplified by the Big Reef (No. 4), Mica Giant (No. 6), M and P Mica (No. 7), and Dixie Queen (No. 13) deposits. The Charleston property (No. 1) is the only deposit of the sericitic vein type known. During the period 1961-66 an average of about 3,000 tons per year of scrap mica was produced in Arizona, and future

production seems to be more dependent upon market conditions than on reserves. — WLG

09200 **Moore, Richard T.** Strontium salts, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 453-456, illus., 1969.

Two deposits of celestite are known in Arizona: in the Vulture Mountains and south of Gila Bend. In the first deposit, celestite-bearing rock occurs in beds up to 2 feet thick interbedded with thin-bedded, olive-buff to light-brown shaly tuff of Tertiary age; the deposit contains more than 180,000 short tons of celestite rock. The second deposit is similar to the first as the principal strontium mineral is celestite, and occurs in beds associated with gypsum, sandstone, and conglomerate; igneous flows and intrusions are also associated with the series. Under present economic conditions, Arizona's strontium deposits are not competitive with foreign supplies, and there is no indication this situation will change in the near future. — WLG

09202 **Moore, Richard T.** Vermiculite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 462-464, 1969.

Comparatively little is known about possible commercial vermiculite deposits in Arizona. Although the mineral has been identified in samples submitted to the Arizona Bureau of Mines from many sections, no large, relatively high-grade deposits are known. An occurrence near Oracle, Pinal County, has been worked for mill-test material but not commercially mined. — WLG

09237 **Moore, Richard T.; Roseveare, George H.** Silver, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 251-270, illus., table, 1969.

Silver has been produced in Arizona from deposits in 60 mining districts, or groups of districts, as shown on a sketch map; a brief geologic description of each is tabulated. The deposits can be grouped geologically into three main classes: siliceous vein deposits, with or without base-metal sulfides; high-grade sulfide deposits, carrying principally either lead, zinc, or copper with silver as an accessory metal; and low-grade disseminated copper deposits, in which silver occurs as a trace metal but from which it is economically recoverable, because of the large tonnages of ore treated. — WLG

Moore, Robert D. *See* Block, Barry. 02130

02159 **Morgan, G. R.; Jackson, D. E.** A probable 'Waulsortian' carbonate mound in the Mississippian of northern Alberta: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 104-112, illus., table, 1970.

Preliminary data suggest the existence of a 'Waulsortian'-type carbonate mound in the Pekisko Formation of Osagian age in northern Alberta. The mound rests upon a platform carbonate at the base of the Pekisko and occurs where this basal limestone shows a marked change in thickness. The known depositional relief of this mound is some 300 feet, and it is thought that fenestrate bryozoans provided the sediment-trapping mechanism. — Authors' abstract

02193 **Morgan, J. W.** Uranium and thorium in tektites, an additional comment: Earth and Planetary Sci. Letters, v. 8, no. 2, p. 141-142, illus., 1970.

The relationship between uranium and thorium in tektites and achondrites is reconsidered in the light of the oxygen isotope compositions of lunar rocks. A correlation is found between the uranium and thorium abundances in three high O-18 achondrites and those in tektites which is particularly strong in the case of the Australasian group. — Author's abstract

Morin, M. *See* Anderson, Alfred T. 09582

09379 **Morris, G. B.** Anizotropiya skorostey v verkhney mantii Tikhogo okeana [Velocity anisotropy in the upper mantle of the Pacific Ocean] *in* Internat. Conf. Experts on Explosion Seismology, 1st. Leningrad, 1968, Trans.: Kiev, U.S.S.R., Akad. Nauk Ukrain. SSR Inst. Geofiziki (Izdatel'stvo Naukova Dumka), p. 162-173, illus., 1969.

Seismic results of the SHOW and HILO expeditions near the Hawaiian Islands corroborate the findings of Raitt and others (1969) that there is a velocity anisotropy in the upper mantle in various regions of the Pacific Ocean, which may be a regional phenomenon. The anisotropy in the vicinity of Hawaii is large, amounting to a difference of 0.6 kmps. Possible causes of such anisotropy are discussed. — DBV

Morris, H. T. *See* Tooker, E. W. 02030

09370 **Morrison, G. H.; Kashuba, A. T.** Multielement analysis of basaltic rock using spark source mass spectrometry: Anal. Chemistry, v. 41, no. 13, p. 1842-1846, illus., tables, 1969.

Spark source mass spectrography has been used for the multielement analysis of the U.S. Geological Survey standard basalt BCR-1. U.S. Geological Survey standard diabase W-1 was used as a multielement concentration standard to obtain sensitivity factors. It has been possible to determine 60 elements using graphite and silver blended rock mixtures as electrodes at several magnet settings and exposure sequences. When the analysis is compared with those of other investigators, including a neutron activation analysis performed on a sample of BCR-1 from the same bottle, agreement was found to be good. — Authors' abstract

09622 **Morrison, G. H.; Gerard, J. T.; Travesi, A.; Currie, R. L.; Peterson, S. F.; Potter, N. M.** Multielement neutron activation analysis of rock using chemical group separations and high resolution gamma spectrometry: Anal. Chemistry, v. 41, no. 12, p. 1633-1637, illus., tables, 1969.

Instrumental neutron activation analysis and neutron activation analysis with a high-resolution lithium-drifted germanium detector, chemical group separations, and a coincidence-anticoincidence system were used to determine 45 elements in U.S. Geological Survey standard rock samples BCR-1, AGV-1, and G-2. U.S. Geological Survey standard rock W-1 was used as the standard. The principal nuclides, their γ-rays used in the determinations, and the best time after irradiation for counting are listed. Nuclides are separated chemically into groups for counting by volatilization, extraction with hydrated antimony pentoxide, ion exchange, and solvent extraction with TBP. Agreement of our results with published data is good. — Authors abstract

Morrison, M. F. *See* Northrop, John. 01959

Morrison, Roger B. *See* Hayes, Philip T. 09157

09611 **Morse, S. A.** Layered intrusions and anorthosite genesis, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 175-187, illus., tables, 1968 [1969].

The Kiglapait layered intrusion, which consists largely of troctolite and subordinate olivine gabbro to ferrosilite, abuts the anorthosite of the Nain area, Labrador, and illustrates extreme closed-system fractionation of a high-alumina basaltic parent. For more than three-quarters of its crystallization history the intrusion produced plagioclase and olivine in a ratio of about 3 to 1. Had the plagioclase floated instead of settled, a sizeable anorthosite body would have resulted. Using the proportion of minerals in the intrusion as a guide, and assuming a plagioclase flotation model for anorthosite, a crude calculation suggests that the total composition of the Nain anorthosite complex is permissive of basaltic parentage. — *from* Author's abstract

Morton, Roger D. *See* Rath, Ulrich. 09485

Moss, M. E. *See* Ligner, J. J. 09265

02169 **Moulder, E. A.** Water pollution control creates demand for groundwater hydrologists: Mining Eng., v. 22, no. 2, p. 90-91, illus., 1970.

This paper reviews the applications of ground-water hydrology to the problems of the mining industry during 1969. Applications discussed include mine dewatering, pollution from mine waste products, searches for water supplies, use of water in dump leaching, hydrochemical mining, and the use of ground water and associated vegetation in mineral exploration. — MAC

Moxham, R. L. *See* Isachsen, Yngvar W. 09594

Moxham, Robert M. *See* Greene, Gordon W. 09555

09434 **Mrakovich, John V.** The Sharon Conglomerate of northeastern Ohio: Compass, v. 46, no. 3, p. 150-158, illus., table, 1969.

The Sharon Conglomerate is a basal Pennsylvanian unit resting unconformably on Mississippian strata, and is really a medium-grained sandstone with north-south linear belts of conglomerate. Both sandstones and conglomerates have a high silica content, and are predominantly crossbedded. As the conglomerates change from massive to planar bedded upward, they become more sandy; similar vertical changes occur in point-bar deposits in meandering streams. The sandstones have more tabular and wedge-shaped, planar crossbedding, produced by transverse bars, a common form of bed-load transport in rivers with high width-depth ratio and in braided streams. — *from* Author's abstract

Mudie, John D. *See* Larson, Peggy A. 01943

Mueller, D. W. *See* Suttle, A. D., Jr. 09295

Mueller, D. W. *See* Albu-Yaron, Ana. 09298

09409 **Mueller, Robert F.** Kinetics and thermodynamics of intracrystalline distributions, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 83-93, illus., tables, 1969.

A general kinetic and thermodynamic model is presented for the distribution of two or more particles between two or more lattice sites. Certain qualitative aspects of the general model are discussed in relation to complex ferromagnesium minerals, and quantitative versions of the equation are developed for the quasibinary case with all sites behaving as ideal solutions. Although the integrated form of the rate equation is obtained only for the ideal two-site case of the quasibinary crystal, the forms of the rate equation and their implicit solutions are also discussed in some detail for three or more sites. An attempt is made also to calculate the specific rate constant and free energy of activation for orthopyroxene; applications to the study of the thermal history of rocks are suggested. — *from* Author's abstract

09228 **Mueller, Robert Francis.** Energetics of hydrogen chloride and hydrogen fluoride in volcanic emanations: U.S. Natl. Aeronautics and Space Adm. Tech. Memo. TM-X-63608, 32 p., 1969.

Thermochemical data are used to calculate the fugacities of HCl and HF in equilibrium with halogen salts and crystalline silicates. The calculated fugacities are compared with the abundances of HCl and HF in fumarolic gases. Good agreement between the calculated values and the results of hydrothermal experiments is also obtained for HF. It is found that in the case of fumaroles the abundances of HCl and HF molecules can be explained by assuming some undersaturation of the systems in such crystalline components as NaCl, $CaSiO_3$ and Al_2SiO_5. Also the fumarolic gases give evidence that high temperature abundances of HCl and HF are quenched to much lower temperatures recorded at the fumarolic vents. The relations between HCl and HF and the structure of the silicate melt are discussed, and certain interpretations are given to experimental phase studies. — Author's abstract

Muir, I. D. *See* Lindsley, D. H. 09505

09418 **Munoz, James L.** Stability relations of $LiAlSi_2O_6$ at high pressures, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 203-209, illus., tables, 1969.

The pyroxene end member $LiAlSi_2O_6$ crystallizes in three stable polymorphic forms. One of these, a C2 pyroxene, is found in nature. One polymorph (β-spodumene) is tetragonal and is a high temperature form at 1-9 kbar. The other (β-quartz$_{ss}$) is hexagonal and is the high temperature polymorph at 10-26.5 kbar. Phase transitions are described. — *from* Author's abstract

01956 **Murphy, Andrew J.; Sykes, Lynn R.; Donnelly, Thomas W.** Preliminary survey of the microseismicity of the northeastern Caribbean [abs.]: EOS, v. 51, no. 4, p. 352, 1970.

02202 **Murray, J. B.; Guest, J. E.** Circularities of craters and related structures on Earth and Moon: Modern Geology, v. 1, no. 2, p. 149-159, illus., table, 1970.

Methods of measuring the circularity of craters and related circular to subcircular structures using a variety of parameters are described, and applied to different types of terrestrial and lunar structures. These measures are found to distinguish different types of terrestrial features of known origin, and the results are compared with those obtained for lunar structures. It is concluded that certain strongly circular lunar craters are most likely to be 'explosive' in origin, and by implication, impact craters; other types of lunar crater that are similar in circularity to terrestrial calderas and ring complexes may be of volcanic origin. — Authors' abstract

Murri, William J. *See* Smith, Carl W. 01981

Murthy, M. K. *See* Smith, Donald E. 09466

01957 **Naidu, A. S.; Burrell, D. C.; Hoskin, C. M.** Sediments of the south Beaufort Sea [abs.]: EOS, v. 51, no. 4, p. 332, 1970.

09225 **Naldrett, A. J.** Discussion of papers concerned with sulfide deposits, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 359-365, illus., 1969.

This discussion is concerned primarily with data presented in papers on the Sudbury ores and nickel deposits associated with ultramafic rocks. The nature of the nickel irruptive and emplacement of sulfide ores are examined for the Sudbury deposit, and the question of genesis of deposits in the ultramafic rocks is considered. Naldrett emphasizes that the texture (here called 'net') of disseminated sulfides in ultramafics discussed by Kilburn, Wilson, and Graham (p. 276) and by Haapala (p. 262) is not diagnostic of the former presence of a sulfide liquid but can result also from replacement of solid rock by sulfides. All deposits should be approached with an open mind and the genesis of the deposits established on the basis of chemical and mineralogic similarity to other deposits where genesis is more certain. — VSN

09609 **Nalwalk, A. J.** Geology of a portion of the north wall of the Puerto Rico Trench, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 403-425, illus., tables, 1969.

Rocks dredged from the north wall of the Puerto Rico Trench indicate that the tentative stratigraphic sequence of the wall in ascending order is Cenomanian limestone, Upper Cretaceous siliceous mudstones and cherts, Upper Cretaceous-Eocene limestone, Upper Cretaceous-Eocene serpentinites, Eocene-Pliocene siliceous mudstones and cherts, pre-Pliocene volcanic wackes, Pliocene basalts and Pliocene-Recent unconsolidated sediments. Two main fault patterns are apparent and trend E-W and NW-SE; the former are older and are terminated by the latter. Magnetic susceptibility, remanent magnetism, and Qn values of the rocks indicate that permanent polarization is responsible for geomagnetic anomalies measured at sea. — *from* Author's abstract

Nation, J. B. *See* Hales, A. L. 01920

09240 **Nauss, A. W.** The Rocky Mountain trench and the Rocky Mountains [with French abs.]: Diatomic Research Bull. 2, p. 21-49, illus., 1969.

A world-wide study of the distribution of tectonic activity with respect to observable factors reveals a relationship between tension and compression and of uplift to thickness and distribution of sediments. These relationships are evident in the Canadian Rocky Mountains and signify that the uplift was the result of a crustal circulation motivated by shifting weights of the surface and aided by the density change of granite formation and intrusion. — Author's abstract

09241 **Nauss, A. W.** Origin of meteorites by epitaxy: Diatomic Research Bull. 2, p. 1-13, 1969.

Meteorites originated by condensation of material ejected from the Sun and are still being formed. The process of condensation was by epitaxy on nuclei and hence tends to be coarsely crystalline. The significance of the large crystals in meteorites is that they crystallized from a vapor phase and not by slow cooling from a liquid phase. The center of meteorites should be older than their surface materials. Planets formed by the agglomeration of meteorites. Signs of this agglomeration, so apparent on the Moon and Mars, should be sought on the ancient preserved surfaces of the Earth. — Author's conclusions

Neathery, Thornton L. *See* Bentley, Robert D. 01903

09436 **Nelson, Gordon C.** A preliminary investigation of Precambrian mafic dikes in the Hesse Mountain-Hazelton Peak area, Bighorn Mountains, Wyoming: Compass, v. 46, no. 4, p. 217-228, illus., tables, 1969.

Crystalline rocks have been intruded by a complex of mafic dikes. Field and petrographic investigations indicate that some dikes are metamorphosed suggesting several episodes of dike intrusion; one is represented by quartz dolerite and quartz diorite dikes, and an older one by metadolerite dikes. The gneissic complex was subjected to metamorphic conditions of the staurolite-quartz subfacies of the almandine-amphibolite facies about 3 b.y. ago. Only the margins of most metadolerite dikes are affected, suggesting their emplacement during waning stages of regional metamorphism represented by gneissic country rock. Progressive changes can be traced from interior to contact in several dikes. Recrystallized border zones closely approximate some concordant amphibolites of the gneissic complex. Thus, amphibolites may represent pre-existing mafic igneous bodies more thoroughly metamorphosed. — *from* Author's abstract

Nelson, T. H. *See* Roeder, D. H. 02069

Nenow, E. V. *See* Wasserburg, G. J. 09461

Newell, N. D. *See* Cox, L. R. 09446

09447 **Newell, N. D.; LaRocque, Aurèle; Keen, A. Myra; Soot-Ryen, T.; Cox, L. R.; Hertlein, L. G.; Weir, John.** Systematic descriptions [subclass Pteriomorphia Beurlen, 1944], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N248-N393, illus., 1969.

Pteriomorphia (Ordovician-Holocene), although morphologically diverse, are accepted by many paleontologists as a phylogenetic unit. They are characteristically epifaunal and sedentary (some groups are secondarily free), many retaining the byssus throughout life or becoming attached by cementation. The foot and anterior adductor tend to become reduced or lost in many most specialized groups. A duplivincular ligament, unknown in other bivalves, characterizes the less specialized Arcacea and several Paleozoic groups. A total of 490 genera and 191 subgenera are described, under 11 superfamilies in orders Arcoida, Mytiloida, and the generally inequivalve Pterioida with six superfamilies including Pteriacea (102 genera), Pectinacea (112 genera), and Ostreacea (51 genera, to be described in Pt. N, V. 3). Some superfamilies show convergent or parallel trends. — VMJ

Newell, N. D. *See* LaRocque, Aurèle. 09448

Newell, N. D. *See* Branson, C. C. 09450

09451 **Newell, N. D.; LaRocque, Aurèle; Cox, L. R.; Keen, A. Myra; Smith, L. A.** Systematic descriptions [subclass Anomalodesmata Dall, 1889], *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 2: New York, Geol. Soc. America (and Univ. Kansas Press), p. N818-N859, illus., 1969.

Anomalodesmata (Ordovician-Holocene) are relatively short to elongate, nestling or burrowing forms, generally isomyarian, with ventrally fused mantle lobe; most living forms are eulamellibranchiate. Shells are equivalve to subequivalve, prismatonacreous; hinge margin characteristically thickened or enrolled, teeth weak or lacking, ligament, where present, opisthodetic, characteristically with internal resilium and lithodesma. Herein, 113 genera and 54 subgenera are described; a single order, Pholadomyoida, comprises the superfamilies Edmondacea, a small, primitive group confined to the Paleozoic; Pholadomyacea, Ordovician-Holocene, a large group of elongate burrowers; Pandoracea, Triassic-Holocene; and Poromyacea and Clavellacea, Cretaceous-Holocene, the latter with degenerate valves embedded in an elongate calcareous tube adapted for burrowing. — VMJ

Newell, N. D. *See* Cox, L. R. 09496

Newell, N. D. *See* Cox, L. R. 09500

09444 **Newell, Norman D.** Classification of Bivalvia, *in* Treatise on invertebrate paleontology — Pt. N, Mollusca 6, Bivalvia, V. 1: New York, Geol. Soc. America (and Univ. Kansas Press), p. N205-N224, illus., tables, revised 1969; originally published 1965.

Classification of bivalves is complicated by numerous cases of homeomorphy, and by commonly poor preservation of critical morphologic details in older fossils. Many groups at the superfamily level are very distinctive, with long evolutionary lineages; grouping these into higher taxa, however, is difficult. Systems of neontologists based on a single feature, such as gill grade, ignore the character complexes on which family-group taxa are based, and are generally not applicable to fossils. The system used here, modified from L. R. Cox (1960) with nomenclature simplified, synthesizes best features of several widely used systems. Of the six subclasses, Palaeotaxodonta and Pteriomorphia are considered natural phylogenetic groupings; Cryptodonta, Palaeoheterodonta, Heterodonta, and Anomalodesmata are probably artificial. — VMJ

Newell, Norman D. *See* Boyd, Donald W. 09449

02026 **Nickel, E. H.** The application of ligand-field concepts to an understanding of the structural stabilities and solid-solution limits of sulphides and related minerals, *in* Geochemical application of crystal-field theory: Chem. Geology, v. 5, no. 4, p. 233-241, illus., tables, 1970.

The metals in sulfides, arsenides, tellurides, and selenides are generally in the low-spin state, and therefore the crystal structure adopted by any one of these minerals is that which permits maximum spin pairing of the nonbonding electrons in the t_{2g} cation orbitals. Cations with six or more nonbonding electrons form structures in which complete spin-pairing is achieved without interaction between cations (as in pyrite, marcasite, skutterudite). Cations with less than six nonbonding electrons achieve spin pairing by structures in which there is a metal-metal interaction. The limits of solid solution fields in ternary systems of sulfides and arsenides are governed by similar considerations. — *from* Author's abstract

09308 **Nickel, E. H.** Bond strength and sulfur isotopic fractionation in coexisting sulfides [discussion of paper by D. J. Bachinski, 1969]: Econ. Geology, v. 64, no. 8, p. 934-935, tables, 1969.

Relative bond strengths decrease in the sequence FeS_2, CoS_2, NiS_2, rather than the reverse order that Bachinski suggested (ibid., v. 64, p. 56-65, 1969). — WSW

02145 **Nielsen, Bjarne Leth.** Paa spor af sjaeldne metaller in Sydgrönland — [Pt.] 8, Man har atter boret paa Kvanefjeldet, kan uranmalmen brydes? [On trace and rare metals in South Greenland — [Pt.] 8, Prospecting activities on Kvanefjeld, uranium metals (with English abs.)]: Grönland 1970, no. 5, p. 129-136, illus., 1970.

Uranium prospecting for the past ten years on Kvanefjeld, the Ilímaussaq intrusion in southwest Greenland, has included detailed geological mapping, numerous surface radioactivity measurements, diamond drilling, and trial excavations. The complexities of the geologic features are such that geologically informative drillings are vital for determination of extension of the radioactive rocks. The necessary but difficult estimations of the economic potential for possible exploitation may show the uranium occurrence is of a size and quality possibly near the limit of what is economically profitable. — *from* Author's abstract

09243 **Nielsen, Irvin.** The amazing Piceance mineral suite and its industrial potential for energy-oil-metals-chemicals: Eng. and Mining Jour., v. 170, no. 1, p. 57-60, illus., 1969.

Dawsonite and nahcolite have been identified in the saline section of the Green River Formation in the central Piceance basin, Colo. The same sodium- and kerogen-rich beds also have large reserves of halite, analcite, and limestone; and the basin has long been known for its Mahogany Ledge oil shale. Minerals composing the saline beds are listed, and the economics of a multiproducts plant are described. At the present time possible uses of the salines are being investigated, especially in fighting pollution by removal of sulfur compounds in stack gas. — ESL

Noble, D. C. *See* McKee, E. H. 02198

Noble, James A. *See* Taylor, Hugh P., Jr. 09262

09399 **Nolf, B.; Nolf, P.** Santa Cruz Island Volcanics, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 91-94, 1969.

Miocene volcanic rock cropping out on the north of the Santa Cruz Island fault are here called the "Santa Cruz Island Volcanics." The rocks are informally divided into four units which are, from bottom to top: Griffith Canyon, Stanton Ranch, Devils Peak, and Prisoners Harbor Members. The flows and volcaniclastics are predominantly andesitic, but are more basic toward the bottom and more silicic toward the top. They were extruded in large part from local centers, many of which are exposed at the present time. Extrusion may have been submarine by the time the Santa Cruz Island volcanism ended. The local nature of volcanism and resulting topographic irregularities produced a complex pattern of unit distribution which has only been grossly outlined by work thus far. — HRC

Nolf, Bruce. *See* Weaver, Donald W. 09625

Nolf, P. *See* Nolf, B. 09399

01958 **Noltimier, H. C.** Fourier analysis of several adjacent North Atlantic ridge magnetic profiles [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

09320 **Normand, David.** The distribution of potassium and rubidium in the Whitehorn Stock, central Colorado: Compass, v. 46, no. 2, p. 73-81, illus., tables, 1969.

The geochemical behavior of potassium and rubidium make these elements useful in interpreting the geologic history of an igneous sample. K-Rb ratios ranging from 160 to 235, have been determined for 25 samples from the Whitehorn Stock, central Colorado. Analysis consisted of a wet chemical separation of the alkalies and flame photometric determinations of rubidium, potassium, and lithium. In the Whitehorn Stock, the change in K-Rb ratio is believed to be related to the order of intrusion, with low K/Rb ratios associated with late stage granodiorite and biotite-granites.

High K/Rb ratios are associated with early stage tonalites and granodiorites. — Author's abstract

01959 **Northrop, John; Morrison, M. F.** Hydroacoustic signals from the 1968-1969 underwater and underground explosions in the Aleutian Arc [abs.]: EOS, v. 51, no. 4, p. 353, 1970.

09169 **Norton, James J.** Lithium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 206-211, illus., table, 1969.

The negligible quantity of lithium minerals produced in Arizona has been mainly in the pegmatitic area near Wickenburg and a clay deposit northwest of Kirkland. Elsewhere little effort has been expended to find lithium minerals and information is scanty. It is possible that brine tests for economic value should also include ascertainment of lithium content. Lithium has been detected in many places and there is still a possibility that an economic deposit will be found. — MCM

09516 **Norvitch, R. F.; Thomas, C. A.; Madison, R. J.** Artificial recharge to the Snake Plain aquifer in Idaho — An evaluation of potential and effect: Idaho Dept. Reclamation Water Inf. Bull. 12, 59 p., illus., tables, 1969.

Major factors in using surplus water for artificial recharge of the Snake Plain aquifer are availability of water, probable effects of water mixing on ground-water quality and physical aquifer properties, and effects of artificial recharge on ground-water levels and aquifer discharge. About 4,000,000 acre-feet of water is recharged annually as a result of irrigation from surface-water sources; 1,100,000 acre-feet of ground water pumped returns to the aquifer. There will probably be no chemical-quality problems involved in large-scale recharge. Predictions from an electric-analog model show that by recharging 3.7 million acre-feet for 10 yr at four places, water-level rises of < 1 to > 5 feet, measured 21 months after recharge stopped, would occur; net result would be 3.3 million acre-feet in storage and 0.4 million acre-feet outflow from springs. Future refinement of the model can be made as additional field data are collected. — *from* Authors' abstract

02178 **Nowlan, J. P.** Memorial to Walter Andrew Bell [1889-1969]: Geol. Assoc. Canada Proc., v. 21, p. 45-46, portrait, 1970.

Nowroozi, Ali A. *See* Seeber, Leonardo. 01976

01960 **Nur, Amos.** Velocity anisotropy in rock with cracks and the effect of stress [abs.]: EOS, v. 51, no. 4, p. 417-418, 1970.

Nuttall, C. P. *See* Cox, L. R. 09443

Nuttli, Otto W. *See* Syed, Atiq A. 01986

02127 **Oakes, Edward L.** Geology and ground-water resources of the Grand Rapids area, north-central Minnesota: U.S. Geol. Survey Hydrol. Inv. Atlas HA-322, 2 sheets, scale 1:48,000, sections, text, 1970.

The best source of ground water in the Grand Rapids area is buried outwash in glacial drift; some is obtained in Precambrian metasedimentary (Animikie) rocks. Ground water may be very hard and high in iron and manganese, but requires only simple treatment. The sheets contain a tabulated explanation of geologic units on maps and sections; graphical illustrations; and tabulations of physical properties of selected wells, selected chemical analyses of ground water, and evaluation of ground-water resources. — MCM

O'Brien, Barbara C. *See* Suttle, A. D., Jr. 09295

Ocola, Leonidas C. *See* Anzoleaga, Rodolfo. 01907

01961 **Ocola, Leonidas C.; Meyer, Robert P.** Evidence relevant to the origin of the mid-continent region and its mineral deposits [abs.]: EOS, v. 51, no. 4, p. 357, 1970.

01962 **O'Connell, Richard J.** Equation of state of spinel to 10 kbar and 800°C [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

Ogura, Y. *See* Kilburn, L. C. 09222

Ohl, Jane P. *See* Fischer, R. P. 01877

09332 **Oles, Keith F.** The Cretaceous seaway of central Oregon [abs.]: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 6, p. 52, 1969.

Olivet, Jean-Louis. *See* LePichon, Xavier. 01946

09587 **Olmsted, James F.** Petrology of the Mineral Lake Intrusion, northwestern Wisconsin, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 149-161, illus., tables, 1968 [1969].

The Mineral Lake intrusion of northwestern Wisconsin is one of several Middle Keweenawan basic intrusives that occur along the southern edge of the western Lake Superior basin. It is 4500 m thick and is stratiform; the bulk composition is anorthositic gabbro. The high mafic mineral content (about 45 percent) of the chill zone suggests that the liquid from which it crystallized must have evolved from a basaltic magma rather than one of anorthositic gabbro composition. Fractionation was toward iron enrichment, and as fractionation continued during emplacement, the attendant increase in density led to flotation of lighter plagioclase crystals causing them to be carried to higher levels in the intrusion. — JWC

09314 **Olson, Richard H.** Some factors to consider in evaluating talc deposits [abs.]: Econ. Geology, v. 64, no. 8, p. 938, 1969.

Olsson, R. K. *See* Cordey, W. G. 02016

O'Neill, Mary E. *See* King, Chi-Yu. 01939

O'Neill, N. J. *See* Taylor, P. T. 01988

09288 **Ontario Dept. Energy.** (and Resources Management, Petroleum Resources Sec.). Oil and gas exploration, drilling and production summary, 1968: Ontario Dept. Energy and Resources Management Paper 69-1, 140 p., illus., tables, 1969.

The four sections of this report contain: a brief summary of the organization of the Petroleum Resources Section; a statistical summary of exploration, drilling and production activity for 1968; a list of all licencees for 1968; and geological and completion data for all wells drilled under permit in 1968. Exploration activity showed a marked increase centered in the Lake Erie, Lambton County, and Hudson Bay-James Bay Lowlands areas. — MCM

09420 **Onuki, Hitoshi; Ernst, W. G.** Coexisting sodic amphiboles and sodic pyroxenes from blueschist facies metamorphic rocks, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 241-249, illus., tables, 1969.

Two pairs of coexisting riebeckites and aegirites and their parent metacherts from near Laytonville, Calif., were analyzed by conventional gravimetric techniques. Under blueschist metamorphic conditions, solid solution among sodic amphiboles is found to extend from near glaucophane toward magnesioriebeckite and riebeckite compositions; no solvus exists in this mineral group. Sodic pyroxenes exhibit a wide range of solid solutions from jadeite to acmite and diopside. Cation proportions, structural site geometries, and ionic sizes are compatible with concentration of manganese in the octahedral M(1) + M(3) sites of the sodic amphiboles investigated but in the 8-fold coordinated M(2) positions of the sodic pyroxenes. Partitionings of Fe, Mn, Mg, Ti, and Al are described. — *from* Authors' abstract

01963 **Onuma, Naoki; Clayton, Robert N.; Mayeda, Toshiko.** Oxygen isotope fractionation between coexisting minerals in chondritic meteorites [abs.]: EOS, v. 51, no. 4, p. 340, 1970.

02217 **Orville, Philip M.** Synthesis of scapolite solid solution and its stability field at 750°C and 4 kb [abs.]: EOS, v. 51, no. 4, p. 434-435, 1970.

02021 **Osborne, Robert H.** The American Upper Ordovician standard — [Pt.] 12, Time-trend analysis of Cincinnatian calcarenites, Hamilton County, Ohio: Jour. Geology, v. 78, no. 3, p. 363-370, illus., table, 1970.

Twelve petrographic variables observed in duplicate thin sections for each of 44 calcarenites collected from the upper 28 m of the Kope Formation and the entire Fairview Formation (28.3 m thick) constitute the basis for a time-trend analysis. Each of these variables is indicative to a varying degree of the relative mechanical-energy level at the depositional site. Resultant trend components show low-energy maxima approximately 17 ± 2m below and 6 ± 3m above the Kope-Fairview contact, and high-energy maxima 9 ± 2m below and 18 ± 2m above this contact. These maxima probably represent small but systematic changes in mechanical energy resulting from small-scale transgressive and regressive events. — Author's abstract

Ostle, D. *See* Bowie, S. H. U. 09366

09139 **Östrem, Gunnar; Stanley, Alan.** Glacier mass-balance measurements, a manual for field and office work (revised edition): Ottawa, Canada Dept. Energy, Mines and Resources, and Oslo, Norwegian Water Resources and Electricity Board, 125 p., illus., tables, 1969; originally published 1966.

To make possible direct comparisons between field data from various glaciers in the several countries expected to participate actively in glaciological research during the International Hydrological Decade (1965-1974), it is essential that data should be collected in a consistent manner, and results be presented in a standard format. This manual, revised as a result of cooperation, describes field procedures followed in Canada and Norway, outlines practical difficulties and indicates how to overcome them, gives hints of practical use for field work, and suggests how the data can be recorded, tabulated, and plotted in graphs and on maps. It also gives a suitable form for a summary of the data to be made in the field, makes suggestions for field accomodation, outlines office procedures, means of data processing, and presentation of final results. — *from* Authors' preface

O'Sullivan, R. B. *See* Averitt, Paul. 09158

09159 **O'Sullivan, R. B.** Crude oil, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 70-77, illus., 1969.

Production of crude oil has been established at seven fields in northern Apache County from strata of Devonian, Mississippian, and Pennsylvanian ages. The distribution, stratigraphy of the productive zones, and a brief description of each field is given. — WLG

09160 **O'Sullivan, R. B.** Natural gas, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 77-83, table, 1969.

All of the marketed natural gas accumulations are in the Paradox Member of the Hermosa Formation in northeastern Apache County. Gas is also present in the Redwall Limestone and in the Tertiary igneous sill intruding the Hermosa Formation at the Dineh-bi-Keyah field, but this gas has not been marketed. The Paradox Member in northeastern Arizona consists of limestone, black shale, some dolomite, and thin interbedded gypsum. Of six fields that produce gas, four are without associated crude oil. Descriptions and production figures for these fields are given. — WLG

09161 **O'Sullivan, R. B.** Other associated gases, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 83-91, illus., tables, 1969.

Other gases associated with natural gas include carbon dioxide, helium, hydrogen sulfide, and nitrogen, and occur at widely scattered localities in northeastern Arizona. Occurrences, production, analyses, and history of the associated gases are given. — WLG

02185 **Overton, Harold L.** Resistivity logging from shale slurries, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. C1-C20, illus., tables, 1970.

A resistivity log can be constructed from measurements made on clay and shale taken from the shale shaker, simultaneously with drilling, allowing for necessary lag to get cuttings to the surface. A complete electric log can be obtained using resistivity of a slurry of shale fines and distilled water, resistivity of slurry filtrate, and sodium ion potential of the slurry filtrate; all measurements may be made fast enough so that at least one log data point can be obtained for each 20–ft depth interval. Theory and case histories show three equations apply in determining overpressures in the earth using shale slurry data. The electric log obtained applies to shale horizons, but it is found practically that changes follow closely those noticed in the sands. The use of shale fines and distilled water allows all salinity and matrix changes to become significant. — *from* Author's abstract

Overton, Harold L. *See* Zanier, Aldo M. 02211

02164 **Owens, E. H.; McCann, S. B.** The role of ice in the Arctic beach environment with special reference to Cape Ricketts, southwest Devon Island, Northwest Territories, Canada: Am. Jour. Sci., v. 268, no. 5, p. 397-414, illus., tables, 1970.

The effects of ice on the form of the beach zone at Cape Ricketts, southwest Devon Island, in particular in the formation of ice mounds and ice-push ridges, are described. Consideration of meteorological data for Resolute, Cornwallis Island, and of ice cover data for the Barrow Strait-Lancaster Sound sea area provides information for a broader discussion of the role of ice in the beach environment. — Authors' abstract

01964 **Page, Robert.** Dating episodes of faulting from tree-rings [abs.]: EOS, v. 51, no. 4, p. 363, 1970.

09539 **Pakiser, L. C.** U.S. transcontinental geophysical survey, a contribution to the Upper Mantle Project [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 599, 1969.

01965 **Pandit, B. I.; Savage, J. C.** An experimental test of Lomnitz's theory of internal friction [abs.]: EOS, v. 51, no. 4, p. 417, 1970.

Papanastassiou, D. A. *See* Wasserburg, G. J. 09461

09403 **Papike, J. J.; Boyd, Francis R.; Clark, Joan R.; Ernst, W. G.; Holser, William T.** (editors). Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, 314 p., illus., tables, 1969.

This volume was published to coincide with a symposium on pyroxenes and amphiboles held at Virginia Polytechnic Institute, Blacksburg, Va., September 7-11, 1969. The papers are grouped in two sections: Pt. 1, Crystal chemistry and intracrystalline cation distributions; and Pt. 2, Phase petrology and intercrystalline cation distributions. — JWC

Papike, J. J. *See* Clark, Joan R. 09405

09413 **Papike, J. J.; Ross, Malcolm; Clark, Joan R.** Crystal-chemical characterization of clinoamphiboles based on five new structure refinements, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 117-136, illus., tables, 1969.

Five new structural refinements of tremolite, C-centered manganoan cummingtonite, primitive manganoan cummingtonite, hornblende, and potassic richterite are compared with published results for cummingtonite, grunerite, and glaucophane. The nature of the cation species occupying the M(4) site is of key importance in amphibole phase relations. The differences between the M(4)-O coordination polyhedra for (Mg, Fe^{2+}, Mn)-clinoamphiboles and (Ca, Na)-clinoamphiboles are largely responsible for the limited miscibility between these amphibole groups at low temperature. The A site is occupied by K in potassic-richterite and by (Na, K) in the Kakanui hornblende. In the aluminous hornblende the T(1) tetrahedron is enriched in Al relative to T(2). — *from* Authors' abstract

Papike, J. J. *See* Ross, Malcolm. 09501

09287 **Papke, Keith G.** Industrial rock and mineral deposits, *in* Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nevada Bur. Mines Bull. 70, p. 108-130, illus., tables, 1969.

Industrial rocks and minerals present in Washoe and Storey Counties and described here are: unconsolidated calcium carbonate; halloysite, montmorillonite and common clays; coal; diatomite; feldspar; pumiceous rhyolite and cinder lightweight aggregates; limestone and dolomite; perlite; saline materials; sand and gravel; silica; stone; and sulfur. Because most have low unit values, they are of economic importance only if they are located reasonably close to the population centers of Reno and Sparks. High unit materials are some of the clays, coal, diatomite, feldspar, perlite, saline materials, silica, and sulfur; possible uses are quite diverse. — MCM

01966 **Parker, Andrew.** The influence of geochemistry on the geotechnical properties of marine clays [abs.]: EOS, v. 51, no. 4, p. 328, 1970.

09173 **Parker, R. L.** Niobium and tantalum, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 238-242, illus., 1969.

Arizona, with a total production close to 3,000 pounds of niobium-tantalum concentrates, ranks sixth among the states as a producer of these elements; pegmatites have been the only commercial source up to the present time. The most well known niobium-tantalum-bearing pegmatites are in the White Picacho district and in the Aquarius Cliffs district of the Aquarius Range; these and other districts, mines, and prospects from which niobium-tantalum minerals have been reported are shown on a sketch map. — WLG

Parrott, William R. *See* Foord, Eugene E. 02218

09376 **Partheniades, Emmanuel; Cross, Ralph H., 3d.; Ayora, Alfredo.** Further results on the deposition of cohesive sediments, Chap. 47 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 723-742, illus., 1969.

Experiments with kaolinite suspensions in a rotating annular channel reveal: the shear stress at the bottom of the channel is almost uniform across the channel as long as deposition was uniform; the average bed shear stress T_b is nearly proportional to $T_{ch}^{1.20}$. Bottom shear stress is the variable controlling the relative equilibrium concentration; the relative equilibrium concentration is related to the shear stress parameter and to the bed shear stress by lognormal relations. Slow and gradual flushing of the suspended sediment at equilibrium confirmed that after equilibrium is achieved, erosion and deposition of fine sediment cannot take place simultaneously, and limited time-concentration data show that instantaneously suspended sediment concentrations and deposition rates depend upon initial concentration and bed shear stress. — *from* Authors' summary

Patterson, J. *See* Lyon, R. J. P. 09563

09231 **Patterson, Sam H.** Clay, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 324-336, illus., 1969.

Clays have been mined in Arizona for many centuries and for many purposes; highest yearly production was in 1964 when 168,000 tons valued at 213,000 dollars was produced. Bentonite has been mined in five districts, more than 90 percent from the Sanders-Chito district in deposits of the Pliocene Bidahochi Formation; resources are undoubtedly large, but little is known about size and grade of individual deposits. Refractory clay and kaolin occur in several rock types; those in the Morenci district are of hydrothermal origin and may contain the best quality kaolin in the state. Miscellaneous clay is mostly clay and shale dug chiefly from Tertiary or Quaternary sedimentary beds; other types are pottery clay, pyrophyllite, and sepiolite found in varying amounts. Geologic investigations are inadequate for meaningful appraisals of future use of clay resources; it is likely that increased demand would lead to further discovery and development. — MCM

Pauken, Robert J. *See* Metter, Dean E. 09491

Paulson, Q. F. *See* Kelly, T. E. 02148

Pautot, Guy. *See* LePichon, Xavier. 01946

02075 **Paynter, Donald D.** Main Pass Block 35 field, Louisiana, paleostructural analysis: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 783-788, illus., 1970.

In the Main Pass Block 35 field, Louisiana, there is no gas cap at the apex of the reservoir in the producing N sand accumulation. The gas cap is present in a structure 120 feet lower in the field. A paleostructural study was made in order to review the growth history of the field and determine the cause of this anomalous hydrocarbon distribution. Apparently the position of the high part of the field has shifted throughout the depositional history of the area. This shift is the result of different rates of subsidence during deposition. — SEF

Peck, Dallas L. *See* Skinner, Brian J. 09258

09486 **Peebles, George A.** Radiometric instrumentation and techniques at Eldorado's Beaverlodge operation: Canadian Mining and Metall. Bull., v. 62, no. 690, p. 1087-1092, illus., 1969.

This paper describes the various types of radiometric instruments and the techniques of their operation for grade control, sampling, assaying and probing drill holes at Eldorado Nuclear's uranium mine in northern Saskatchewan. Modifications that have been made to these instruments are discussed, and suggestions are made for the development of more refined and specialized radiometric equipment. — Author's abstract

09194 **Peirce, H. W.** Perlite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 403-407, illus., 1969.

The locations of the principal perlite occurrences in Arizona are shown on a sketch map. Of primary importance, because of large potential reserves and commercial development, is the Picketpost Mountain area, southwest of Superior. According to Wilson and Roseveare (1945) a 5- to 100-ft thickness of perlite is associated with a rhyolitic volcanic phase which is only a part of a larger volcanic complex, presumably of Tertiary age, that attains a maximum thickness of 1,970 feet in Picketpost Mountain. Other large deposits have also been noted in southern and middle parts of the Black Mountains, Mohave County, and in Yuma, Maricopa, Gila, Greenlee, and Pinal Counties. — WLG

09164 **Peirce, H. Wesley.** Chromium, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 113, 1969.

Chromium, best known in chrome plating and as the chief alloying constituent of stainless steel, is vital to modern industrial nations; chromium mineral is chromite. Large primary deposits of chromite are associated with ultramafic rocks such as peridotite, norite, and dunite; only two occurrences of such rocks occur in Arizona and both are older Precambrian in age. Although it is likely that new occurrences will be found, especially in the ultramafic rocks associated with the older Precambrian of central Arizona, the possibilities for discovering commercial chromite deposits in Arizona appear remote. — WLG

09176 **Peirce, H. Wesley.** Tin, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 270-271, 1969.

The major commercial tin deposits of the world occur in placers derived from weathering and erosion of cassiterite-bearing, felsic, plutonic igneous rocks such as granite and quartz monzonite. Although Arizona has abundant occurrences of similar plutonic igneous rocks, only two occurrences of cassiterite have been reported: in the White Picacho district of Maricopa County, and east of Safford, Graham County. The possibility of commercial tin deposits in Arizona is remote; however, the U.S. Geological Survey has initiated a study of domestic resources of certain heavy metals, including tin, and additional information on the occurrence and distribution of tin may result from this program. — WLG

09185 **Peirce, H. Wesley.** Diatomite, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 337 [illegible], illus., 1969.

Diatomaceous occurrences in Arizona are associated with sedimentary sequences that accumulated in lacustrine and related environments that, at least locally, prevailed in late Cenozoic time. The major (southeastern) and minor occurrences of diatomite are shown on a sketch map. All but one of the 12 occurrences occur in valleys within the Basin and Range province where they are exposed along canyons and washes tributary to the northwesterly-trending main drainage lines. — WLG

09188 **Peirce, H. Wesley.** Gem materials, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 357-364, illus., 1969.

Gem materials occur in all of Arizona's 14 counties where the distribution of each gem substance is controlled by the distribution and extent of a particular geologic environment. The best known gem materials are: silicified wood, chalcedony, agate, jasper, amethyst, and clear quartz crystal among the quartz family; turquoise, chysocolla, malachite, and shattuckite among the copper minerals; peridot; pyrope garnet; marekanite; and onyx marble. A sketch map shows the principal occurrences of these materials and each material is discussed briefly. — WLG

09197 **Peirce, H. Wesley.** Salines, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 417-424, illus., table, 1969.

The potential for exploitation of Arizona's saline resources [sodium chloride, potassium chloride, sodium sulfate, calcium sulfate, natural brines] varies according to projected usage and economic conditions surrounding each use. The development of a local sodium chloride industry is possible within the near future, whereas the development of an industry to exploit potassium chloride in the Supai salt basin near Holbrook in the near future seems doubtful. The indirect use of halite deposits as storage sites for petroleum products, natural gas, helium, or radioactive wastes is a possibility, especially those near processing plants and existing transportation routes. The possibilities for discovering new saline resources in Arizona are good, especially

by accidental encounter during drilling operations in the basins of the Basin and Range province. — Author's outlook

Pelly, I. *See* Laul, J. C. 01945

09282 **Penny, John S.** Late Cretaceous and early Tertiary palynology, [Chap.] 16 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 331-376, illus., tables, 1969.

Worldwide transgressions, regressions, and orogenies of the Cenomanian-Oligocene interval, during which mild tropical to temperate climates prevailed, coincided with extraordinary evolution and dispersal of angiosperms, insects, and mammals. Angiosperm pollen, underrepresented through Cenomanian time, had become dominant by Senonian time in the Northern Hemisphere. By late Senonian, pollen floras show more types assignable to extant genera; western North American floras attain a modern aspect sooner than those of central Europe. Transition to the Paleocene was marked by great faunal changes but no comparable floral changes. Basic structure of pollen exines was fully evolved by Eocene time; pollen and megafloras indicate differing environments and are discussed by provinces. Onset of drier and cooler climate in the Oligocene caused major vegetational changes leading to modern floras. — VMJ

Perkins, B. F. *See* Chavan, André. 09497

09482 **Pérusse, Jacques.** The Pekan deposit, Gaspé, Quebec: Canadian Mining and Metall. Bull., v. 62, no. 688, p. 824-828, illus., 1969.

In 1963, regional geology and aerial photo-interpretations of the Gaspé Park region were used to select areas to be acquired by staking. Geological, geochemical, and geophysical surveys outlined anomalies on the properties, one of which was the Pekan property. Drilling proved the Pekan anomaly to be the surface expression of the Pekan deposit, which occurs in metamorphosed impure limestone intruded by acidic porphyries and mineralized with chalcopyrite, molybdenite, sphalerite, pyrite, pyrrhotite, hematite, and magnetite. Full credit for the discovery of the deposit is given to geochemical techniques, and ground magnetometer surveys were used to indicate the most favorable drill targets. The geochemical and geophysical techniques that were used to locate the deposit are presented in this paper. — Author's abstract

Petersen, Carl F. *See* Smith, Carl W. 01981

Peterson, S. F. *See* Morrison, G. H. 09622

09343 **Pettijohn, F. J.; Gair, J. E.; Wier, K. L.; Prinz, W. C.** Geology and magnetic data for Alpha-Brule River and Panola Plains areas, Michigan: Michigan Geol. Survey Rept. Inv. 10, 12 p., illus., tables, geol. maps, 1969.

The area lies along the southeastern flank of the Iron River-Crystal Falls synclinorium. Folded strata of the Animikie series trend south to southeasterly. From north to south major folds decrease in magnitude and frequency, and some stratigraphic units change in thickness and lithologic character. A northwest-trending fault, with a horizontal displacement of 1,500 feet, is inferred in the north. Most of the iron-formation is unoxidized and ore has been shipped from only one mine. Two geologic maps of the Alpha-Brule River area and one of Panola Plains carry magnetic data and drill hole exploration information. Panola Plains lies to the northeast and is intruded by two dike-like granitic bodies. Principal structure is a northwesterly plunging anticline, cored by Badwater Greenstone. Two interpretations of the absence of greenstone from its normal stratigraphic position are given. — *from* Authors' abstract

01967 **Phillips, J. D.; Luyendyk, Bruce P.; Hollister, C. D.** Geophysical study on the Mid-Atlantic Ridge and the Atlantis Fracture Zone [abs.]: EOS, v. 51, no. 4, p. 330-331, 1970.

09590 **Philpotts, A. R.** Parental magma of the anorthosite-mangerite suite, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 207-212, illus., table, 1968 [1969].

Textures and structures of undeformed anorthosite masses suggest a relationship to layered basic intrusives; however, they differ mineralogically. Negative gravity anomalies over all major anorthosite bodies indicate the absence of any high density material at depth. Large quantities of mangeritic rocks are invariably associated with anorthosites; if genetically related, the bulk composition of the assemblage is granodiorite. Diorite dike rocks are commonly associated with anorthosites and may represent the parental magma. Experiments show that olivine basalt, which normally crystallizes first, can be made to crystallize plagioclase first by the addition of granitic fractions. It is suggested that anorthosites form when basaltic magmas become contaminated with anatectic melts when intruded into zones of ultrametamorphism, and hence crystallize plagioclase first. — *from* Author's abstract

09586 **Phinney, William C.** Anorthosite occurrences in Keweenawan rocks of northeastern Minnesota, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 135-147, illus., table, 1968 [1969].

Anorthosites in northeastern Minnesota occur as: (1) inclusions in dikes, sills, flows, and gabbro; (2) accumulations of phenocrysts in porphyritic sills; (3) layers in gabbroic anorthosite; and (4) lenticular masses in troctolite. In addition, more than half the Duluth Complex is gabbroic anorthosite. As to origin, gabbroic and peridotitic differentiates at the base of the continental crust could provide a source for either diapiric intrusions of anorthosite or for inclusions in ascending magma. Mechanical separation of plagioclase could easily account for accumulation of phenocrysts and settled layers. The lenticular masses may have formed as segregations during ascent of magma. — *from* Author's abstract

09553 **Pincus, Howard J.** The analysis of remote sensing displays by optical diffraction, *in* Symposium on remote sensing of environment, 6th Internat., Ann Arbor, Mich., 1969, Proc., V. 1: Ann Arbor, Mich., Univ. Michigan, Willow Run Labs., p. 261-274, illus., 1969.

Through diffraction patterns generated with coherent light, features recorded in photographs can be described quantitatively in terms of their directions, spacings and symmetries. In addition, a filtered image of the input can be reconstructed, excluding input elements of specified directions or spacings. A large variety of photographs, both published and original, is amenable to spatial frequency analysis and filtering by optical diffraction. — Author's abstract

Plant, A. G. *See* Dence, M. R. 01902

Podolsky, T. *See* Souch, B. E. 09259

09593 **Pollack, H. N.; Roy, R. F.** The effect of the anorthosite body on terrestrial heat flow and subsurface temperatures in northern New York [abs.], *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 253, 1968 [1969].

Porath, H. *See* Camfield, P. A. 02065

Porath, Hartmut. *See* Dziewonski, Adam. 01885

02067 **Porath, Hartmut; Gough, D. I.** Geomagnetic deep sounding and upper mantle structure in the southwestern United States [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

02190 **Porter, Christopher R.; Carothers, James E.** Formation factor-porosity relation derived from well log data, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. A1-A18, illus., tables, 1970.

Data derived from deep induction-density log combination in shallow invaded water sands have been averaged and combined to define an in-place formation factor-porosity relation (F); 2295 formation factors were calculated and plotted using data from 11 wells from the offshore California Pliocene and 4 wells from offshore Texas-Louisiana Miocene. The 1575 formation factors calculated from the California data indicate $F = 2.45/\Phi^{1.08}$; for the 720 from the Gulf Coast, $F = 1.97/\Phi^{1.29}$. Plots are presented of data from all wells with a combination data plot from all wells in each geological province. It is concluded that reliable formation factor-porosity relations can be defined using well-log data. Care should be exercised in the transfer of these relations from one geological province to another. — *from* Authors' abstract

01968 **Porter, Lawrence D.** An application of generalized inverse theory to local magnitude determination [abs.]: EOS, v. 51, no. 4, p. 357, 1970.

Potter, N. M. *See* Morrison, G. H. 09622

02208 **Poupon, A.; Gaymard, R.** The evaluation of clay content from logs, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. G1-G20, illus., 1970.

Since many log readings are substantially affected by clay in the formation, a reliable evaluation of the clay content is essential in formation evaluation from logs. The method presented to solve this complex problem is based on the consideration of several "clay indicators" evaluated statistically over the interval of the well to be interpreted. These indicators are either single curves such as the SP, Gamma Ray, or Neutron, or combinations of two curves such as Neutron and Density logs. Each clay indicator is calibrated so as to give either the actual clay content or an upper limit of that value. Then the lowest of these indications is likely to be very close to the actual value. The method is applicable not only for shaly sands, but also for complex lithologies. — Authors' abstract

Press, Frank. *See* Kanamori, H. 02128

01884 **Preston, Richard D.** Occurrence and quality of ground water in Throckmorton County, Texas: Texas Water Devel. Board Rept. 113, 51 p., illus., tables, 1970.

Permian rocks of the Wichita and Cedar Fork Groups are found at the surface and Quaternary alluvial deposits are found along major streams in Throckmorton County. Small amounts of ground water for domestic and livestock needs are produced mainly from the Permian Lueders Formation and the Quaternary deposits. Water quality varies widely; high concentrations of sodium, calcium, chloride, and nitrate are due to various kinds of contamination. Methods of disposal of oil-field brines are the probable cause of some of the poorer water quality. — *from* Author's abstract

09623 **Price, W. A.** Variable dispersion and its effects on the movements of tracers on beaches, Chap. 21 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 329-334, illus., 1969.

To arrive at a quantitative assessment of sediment transport using tracers it is usual to analyse the results using the centroid method. It is quite satisfactory to apply such a method when the dispersion from any cause is constant over the area under study. However, when tracers are used in a variable dispersive field, as on a beach, the interpretation of the results by normal methods can give misleading results. A simple arithmetical model is used to illustrate the ideas put forward in the paper. — Authors summary

Priest, Melville S. *See* Shindala, Adnan. 02101

Prinz, W. C. *See* Pettijohn, F. J. 09343

09356 **Prior, J. W.** Profiles between Manitoulin Island and Tobermory (Bruce Peninsula), *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 300-305, illus., 1969.

Two hydrographic and seismic profiles were run between Tobermory and Fitzwilliam Island as part of a pipe line feasibility study. The study showed that the shortest course was unsuitable with many rock ledges on lake bottom. A more easterly course showed a predominantly sediment covered lake floor. A gorge within the bedrock east of Yeo Island is observed to trend and deepen to the northeast. — Author's abstract

Puri, H. S. *See* McAlester, A. L. 09445

Purpura, J. A. *See* Stuiver, Minze. 09371

01969 **Raleigh, C. Barry; Bohn, Joyce; Healy, John H.** Earthquakes and fluid pressure in the Rangely oil field, Colorado [abs.]: EOS, v. 51, no. 4, p. 351, 1970.

Ramlal, K. *See* Wilson, H. D. B. 09264

Rao, Kunduri V. *See* Deutsch, Ernst R. 01888

09485 **Rath, Ulrich; Morton, Roger D.** Base metal occurrence in the Wollaston Lake belt of northern Saskatchewan: Canadian Mining and Metall. Bull., v. 62, no. 689, p. 961-966, illus., 1969.

After briefly reviewing the history of the more significant prospecting activities for base metals along the Wollaston Lake belt, a summary of the regional geology is presented. Preliminary investigations of a base-metal occurrence found in the vicinity of Janice Lake suggest that at least some of the base-metal mineralization within the belt is of syngenetic sedimentary origin. The mode of occurrence of this mineralization may be compared with proven sedimentary ores of eastern Siberia. A consideration of the metamorphic assemblages encountered along this belt suggests possibilities of regional hypogene base-metal zonation. Certain regional exploration target areas are also considered. — Authors' abstract

01970 **Rauch, Henry W.; White, William B.** Solution kinetics of Middle Ordovician carbonate rocks from central Pennsylvania [abs.]: EOS, v. 51, no. 4, p. 285, 1970.

Raymer, L. L. *See* Brown, H. D. 02207

Rea, B. D. *See* Verille, G. J. 02152

02018 **Reeves, C. C., Jr.** Origin, classification, and geologic history of caliche on the southern High Plains, Texas and eastern New Mexico: Jour. Geology, v. 78, no. 3, p. 352-362, illus., 1970.

Caliche forms on calcareous-rich sands, loess, or carbonate rocks in areas subject to geologically short-lived changes between semi-arid and humid climate. Caliche profiles result from a pedogenic process in which carbonate, derived largely from loess distributed during semi-arid times, is carried downward and laterally by infiltrating water during humid times. Induration of the caliche results from exposure and from deposition of diagenetic quartz and carbonate. Differences in age, physical factors, and chemistry allow classification of the caliche into young, mature, and old types. It has formed in Pliocene, Pleistocene, and Holocene time, but principally during the Pleistocene because of climatic fluctuations of that epoch. — DRM

Rehrig, W. A. *See* Laughlin, A. W. 09310

Reynolds, M. A. *See* Miller, Donald K. 01955

09595 **Reynolds, Robert C., Jr.; Whitney, Philip R.; Isachsen, Yngvar W.** K/Rb ratios in anorthositic and associated charnockitic rocks of the Adirondacks, and their petrogenetic implications, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 267-280, illus., tables, 1968 [1969].

A mean K:Rb ratio of 1470 was found for the main Adirondack anorthosite massif. This value is distinctly higher than the K:Rb ratio in normal crustal rocks but quite

similar to that of oceanic tholeiite and basaltic achondrites; this suggests derivation from near the crust-mantle boundary. Norite-charnockite rocks peripheral to the Snowy Mountain anorthosite give K:Rb ratios that range outward from the anorthosite core from 1,000 to 400; this decrease shows significant negative correlation with Differentiation Index, si, alk, and k, and positive correlation with c and mg, suggesting an igneous differentiation series. The uncommonly high K:Rb ratio of the mangeritic rocks suggests an origin of the magma in the deep crust. — *from* Authors' abstract

09554 **Richards, J. Howard.** (editor). Atlas of Saskatchewan: Saskatoon, Saskatchewan, Univ. Saskatchewan, 268 p., illus., tables, 1969.

Most of the 12 sections of this atlas contain nongeologic material; however, section 1 contains a bedrock geologic map, scale 1:6,000,000, and section 2 with scale 1:2,750,000. Section 4 contains maps and descriptive texts on physiographic regions, physical features, glacial geology, water resources, and soils. Section 8 covers economic geography and minerals. The appendix includes a bibliography for each section of the atlas, a gazeteer of physical features, and a gazeteer of settlements and other features. — MCM

Richardson, A. *See* Watkins, N. D. 01997

09278 **Richardson, J. B.** Devonian spores, [Chap.] 11 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 193-222, illus., table, 1969.

Continental strata, practically absent from the geologic column before the Upper Silurian, increase during the Devonian; trilete spores from evolving land plants, most abundant in continental and marginal marine strata, can be used in correlations if stratigraphic control for the beds is known. Broad geographic control (floral provinces), lithofacies and depositional environment may account for differences in spore assemblages of comparable age. A range chart shows known stratigraphic distribution of 69 Devonian spore genera, of which 43 first appear in Lower Devonian rocks. Earliest Devonian spores are very small, probably all homosporous; heterospory is established by late Middle Devonian, with increase in size, size range, and diversity of sculpture. Twenty-two spore genera are described; botanical affinities are given where known. — VMJ

02177 **Ridler, R. H.** Relationship of mineralization to volcanic stratigraphy in the Kirkland-Larder Lakes area, Ontario: Geol. Assoc. Canada Proc., v. 21, p. 33-42, illus., 1970.

The Archean stratigraphy of the Kirkland-Larder Lakes area is characterized by two complete and one partial volcano-sedimentary cycles. Gold and iron mineralization show a spatial preference for the salic volcanic portions of the cycles. The most pronounced chemical trend is a general increase in potash with time. The Boston iron formation has an auriferous carbonate facies correlative, and both are placed in the Timiskaming complex. A syngenetic-metamorphic origin is postulated for all the economically significant gold occurrences. Thus, not only all the economically significant iron mineralization but also all the economically significant gold mineralization appear to be Timiskaming in age and genetically related to the youngest and most highly differentiated salic volcanic phase known. — Author's abstract

09402 **Rietman, J. D.; Aldrich, J. K.** Gravity survey of the Northern Channel Islands, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 109-114, illus., table, 1969.

The islands form an east-west trending gravity high which appears as a westward continuation of the Santa Monica Mountains. The high is the result of the superimposition of three large-scale anomalies on a northeast-trending regional gradient. Steep gradients are associated with several of the major faults of the islands. Several small

scale lows are associated with outcrops of the Monterey Formation. A decrease in gravity eastward probably results from a deepening of the basement. — HRC

09383 **Riley, D.; Arnold, P. W.** Hydrogen-magnesium, hydrogen-sodium exchange equilibria and the formation of "exchangeable" aluminum: Soil Sci., v. 108, no. 6, p. 414-418, illus., 1969.

The amount of "exchangeable" aluminum formed in soils under mildly acidic conditions is governed by their amounts of exchangeable hydrogen and not solely by the pH of the equilibrium solution. H^+-Mg^{2+} and H^+-Na^+ soils become unstable and form "exchangeable" aluminum. Wyoming bentonite and a mined kaolinitic clay sample possess very few "pH dependent" cation exchange sites. — JWH

Ritter, Dale F. *See* Foord, Eugene E. 02218

09464 **Robertson, David S.; Douglas, Richard F.** Sedimentary uranium deposits [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 195, 1969.

09478 **Robertson, James A.** Geology and uranium deposits of the Blind River area, Ontario: Canadian Mining and Metall. Bull., v. 62, no. 686, p. 619-634, illus., tables, 1969.

This paper is the result of a continuing investigation begun in 1953. Previous work is reviewed and development of several stratigraphic nomenclatures and correlation schemes is traced. The area is underlain by three Precambrian units: Archean greenstones and granites, Huronian sedimentary and volcanic rocks, and post-Huronian intrusive rocks. The Huronian rocks were laid down in shallow water transgressing over the Archean; a northwesterly source and northerly overlap are indicated. Polymictic conglomerates represent tillites. Post-Huronian igneous activity is related to several phases of late Precambrian deformation: sills of Nipissing diabase and younger dikes, Cutler Granite and Croker Island Complex, and Keweenawan olivine diabase dikes. Copper mineralization is associated with the first phase. Uranium ores are found near the Huronian-Archean unconformity. Future discoveries in the area will probably be the result of systematic deep-drilling programs. — *from* Author's abstract

09421 **Robinson, Peter; Jaffe, Howard W.** Chemographic exploration of amphibole assemblages from central Massachusetts and southwestern New Hampshire, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 251-274, illus., tables, 1969.

Chemical and electron-probe analyses were made of amphiboles from plagioclase amphibolites of the kyanite and sillimanite zones of central Massachusetts and southwestern New Hampshire. The rocks contain the following associations: hornblende-anthophyllite, hornblende-cummingtonite, anthophyllite-cummingtonite, hornblende-anthophyllite-cummingtonite, anthophyllite-cordierite, and anthophyllite-kyanite-sillimanite-staurolite-garnet. The cummingtonites are compositionally simple, but the anthophyllites contain nearly the same variety of Na/Al and Al/Al substitution as do the hornblendes. The compositional field of anthophyllite is irregular. For a very limited bulk composition, a stable three amphibole field can be determined: hornblende (with cummingtonite lamellae), cummingtonite (with hornblende lamellae), and anthophyllite (with submicroscopic gedrite lamellae). — JWC

02069 **Roeder, D. H.; Nelson, T. H.** Fossil subduction zones in the North America Cordillera [abs.]: EOS, v. 51, no. 4, p. 421, 1970.

Romey, William D. *See* deWaard, Dirk. 09599

Romey, William D. *See* Boone, Gary M. 09600

Roots, E. F. *See* Sobczak, L. W. 02179

Roseboom, Eugene H., Jr. *See* Bell, Peter M. 09415

09162 **Roseveare, G. H.** Antimony and other minor metals, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 93-102, illus., 1969.

Antimony, arsenic, bismuth, cadmium, selenium, and tellurium occur primarily as accessory elements in many metallic ores and thus their production is largely as byproducts. Each of the minor metals is reviewed briefly as to general qualities, uses, occurrences, market conditions, and the outlook for recovery from Arizona's base-metal ores. — WLG

Roseveare, George H. *See* Moore, Richard T. 09237

02081 **Ross, David A.** Atlantic continental shelf and slope of the United States — Heavy minerals of the continental margin from southern Nova Scotia to northern New Jersey: U.S Geol. Survey Prof. Paper 529-G, p. G1-G40, illus., tables, 1970.

The study of the heavy-mineral fraction of the sand fraction, and to a lesser degree the light-mineral fraction, has indicated 15 heavy-mineral provinces within the area of study. Mineral composition is controlled mainly by source, although mineral assemblages have been modified by selective sorting, weathering, or diagenetic processes. Modification is most pronounced in the high-energy areas of Georges Bank, off Cape Cod, and on the Long Island Shelf. Over the entire area of study the percentages of several heavy minerals have a significant correlation with grain size. However, within the heavy-mineral provinces, differences in grain size generally cannot account for differences between the provinces. —DAR

02154 **Ross, Donald C.** Pegmatitic trachyandesite plugs and associated volcanic rocks in the Saline Range-Inyo Mountains region, California: U.S. Geol. Survey Prof. Paper 614-D, p. D1-D29, illus., tables, geol. maps, 1970.

Two small late Tertiary volcanic plugs on the west flank of the Saline Range grade from fine-grained pilotaxitic trachyandesite at their margins to coarse-grained, miarolitic, pegmatitic rocks at their cores. The plugs intrude layers of cinder, ash, and tuff that lie immediately beneath a vast volcanic cap whose black olivine-bearing rocks are dominantly trachyandesites containing about 2 percent K_2O. Chemical analyses and semiquantitative spectrographic analyses were determined for 16 volcanic specimens; these data are supplemented by determinations of index of refraction of fused-glass beads from 54 volcanic specimens. K-Ar determinations from K-feldspar and clinopyroxene of one of the plugs and from three whole-rock samples of capping flows give uppermost Pliocene ages. These new chemical data extend the large area in the Sierra Nevada and western Great Basin where late Cenozoic mafic volcanic rocks seem to be typically alkaline and particularly rich in K_2O. — *from* Author's abstract

Ross, Malcolm. *See* Papike, J. J. 09413

09501 **Ross, Malcolm; Papike, J. J.; Shaw, K. Wier.** Exsolution textures in amphiboles as indicators of subsolidus thermal histories, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 275-299, illus., tables, 1969.

New chemical, optical, and X-ray observations demonstrate that exsolution in calcic amphiboles, cummingtonites, and orthoamphiboles is common. Most hornblendes, tremolites, and actinolites examined contain exsolution lamellae of either C-centered or primitive cummingtonite. Most primitive and C-centered cummingtonite studied contains exsolution lamellae of either hornblende, actinolite, or tremolite. Sodium- and aluminum-poor anthophyllite and sodium-aluminum-rich gedrite often contain exsolution lamellae of gedrite and anthophyllite, respectively. Some amphibole grains have undergone nearly complete intragranular recrystallization with two amphiboles segregating into two distinct areas of the grain. Possible phase relations between primitive and C-centered cummingtonite and the calcic amphiboles are given. — *from* Authors' abstract

09442 **Rossmann, Ronald; Callender, Edward.** Geochemistry of Lake Michigan manganese nodules, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 306-316, illus., tables, 1969.

Nodules occur on the sediment surface of the Green Bay and the northern lake area. Analyses for nine elements were made and the nodules average 20 percent iron and 6 percent Mn. The trace-element content is considerably lower than in marine nodules. Interstitial water is one of the major contributors of Mn and Fe for the growth of nodules in the lake. Cores of Green Bay sediment show an inverse relation between sedimentary and interstitial Mn, the former increasing to a maximum at the sediment-water interface. Sedimentary Fe remains constant whereas interstitial Fe decreases slightly toward the interface. Lake water may be more than a passive contributor of Fe and Mn. As much as 1/2 the Mn in the lake water is particulate, the source of which is believed to be iron deposits of the Canadian shield. — *from* Authors' abstract

09533 **Rost, F.** Discussion on the paper "The origin of ultramafic and ultrabasic rocks" by P. J. Wyllie, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 519-520, 1969.

On the basis of 20 years of study of ultramafic rocks of the European basement, a 'facies diagram' of orogenotype peridotites has been deduced, conforming with experimental results (1968). The olivine nodules, ultramafics of the Ivrea-Verbano zone, and the Pyrenees can also be arranged in this diagram. Depending on depth of the M-discontinuity (20-60 km) and the corresponding pressures of 6-18 kbar, mantle peridotites can belong both to the spinel-peridotite facies and to the garnet-peridotite facies. After partial fusion of the basic part of the original pyrolitic mantle material, the residual ultramafics of wide composition range (dunite-peridotite-pyroxenite) can be layered in different rock types. These mantle-rock assemblages are probably tectonically deformed by deeper convection in the mantle; the accidentally banded mantle rocks are moved in the solid state by tectonic processes in an orogene. — VSN

09152 **Rothé, J. P.** The seismicity of the Earth, 1953-1965 [with English and French texts]: Paris, UNESCO, 336 p., illus., tables, 1969.

This volume, intended to represent a continuation of the work *Seismicity of the Earth* by B. Gutenberg and C. F. Richter, is a regional catalog of earthquakes of magnitude 6 or greater. Some 400 to 600 earthquakes are analyzed for each year; data are tabulated for 51 separate regions with date, origin time, geographic coordinates of the epicenter, depth of focus, magnitude, and number of stations recording the shock given for each earthquake. A summary of observations and a bibliography are given for earthquakes which caused damage. Epicenter maps are included for the years 1963 through 1965. Earthquakes are classified by main tectonic regions: Scandinavian shield, Hercynian belt, Alpine belt in the Mediterranean basin and in Asia, circumpacific belt, African rift, Indo-Atlantic median ridge, and Indo-Antarctic seismic zone. — VSN

09144 **Rowett, Charles Llewellyn.** Upper Paleozoic stratigraphy and corals from the east-central Alaska Range, Alaska: Arctic Inst. North America Tech. Paper 23, 120 p., illus., tables, 1969.

Very thick Pennsylvanian and Permian eugeosynclinal marine sedimentary and volcanic deposits, overlying Devonian and older metamorphic rocks, are exposed in the area of Rainbow Mountain and the upper Delta River in several separated fault blocks, complexly folded and faulted. A Lower Pennsylvanian 'Rainbow Mountain sequence' and a Lower Permian 'McCallum Creek sequence' have been recognized and correlated by corals and associated brachiopods and fusulinids. Fifteen species of Rugosa (7 new) and three of Tabulata (2 new) are described. The rugose *Cryptophyllum striatum* n.sp. and the tabulate *Cladochonus* sp. occur in the Pennsylvanian sequence. The Permian sequence contains at least 11 coral zones, each characterized

by only one or two, but abundant, species. The coral fauna closely resembles that of the Lower Permian of the Ural Geosyncline and Moscow Basin of Russia, not those of North America. — VMJ

Roy, R. F. *See* Pollack, H. N. 09593

02070 **Ruddiman, William F.** Southward penetrations of the North Atlantic polar front in the late Pleistocene [abs.]: EOS, v. 51, no. 4, p. 332, 1970.

09357 **Rukavina, N. A.** Nearshore sediment survey of western Lake Ontario, methods and preliminary results, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 317-324, illus., table, 1969.

Six bottom sediment types have been recognized and delineated in western Lake Ontario: bedrock, 23 percent; glacial drift, 39 percent; the recent sediments, gravel and pebbly sand, 9 percent; sand, 12 percent; silt-sand, 10 percent; and silt-clay, 7 percent. Recent sediments occur: on the south shore from Niagara to Jordan; on the west shore opposite Burlington Bar; and on the north shore opposite metropolitan Toronto. The deposits at Toronto and Niagara result from local erosion of shore bluffs; westward-moving longshore currents supply the sediment accumulating offshore from the Burlington Bar. — *from* Author's abstract

02151 **Ruley, E. E.** "Big Injun" oil and gas production in north-central West Virginia: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 758-782, illus., table, 1970.

The "Big Injun" zone includes (1) the "Big Injun" sandstone member near the top of the lower Mississippian Pocono Formation; (2) dolomite in the basal part of the overlying Greenbrier Formation; and (3) an overlying sandy limestone. In north-central West Virginia, all recently discovered "Big Injun" production is from dolomite concentrated in the basal 20-60 feet of the Greenbrier. Dolomite indicates a shallow-water, high-energy environment associated with a transgressive sea and favorable to reef growth; an oil-saturated, northeast-trending reef was found in Doddridge County and others are suspected. Based on present reserve estimates and on 50 percent recovery, the Greenbrier "Big Injun" should produce an additional 100 million bbl of oil.

02199 **Rumney, George R.** The geosystem — Dynamic integration of land, sea and air: Dubuque, Iowa, Wm. C. Brown Publishers, 135 p., illus., tables, 1970.

Land, sea and air are united in a *geosystem* which is constantly self-modified by their interaction. The solar system and landforms affect the energy budget of the atmosphere which, in turn, affects the land through radiation, heat and evapotranspiration. Circulation in all layers of the atmosphere creates air streams which transport energy, matter and momentum over the surface of the land and sea. Surface and subsurface circulation of the sea affects both land and atmosphere. Coastal areas show this interaction especially well in various types of beaches and reefs, produced or affected by winds, wind-driven and tidal waves and currents, and seismic sea waves. Effects of precipitation, stream transport and drainage on the land and sea are described as well as the interrelationship of climate, vegetation and soils and their relation to the geosystem. — EH

09566 **Runcorn, S. K.** A palaeontological method of testing the hypothesis of a varying gravitational constant, *in* The application of modern physics to the earth and planetary interiors (S. K. Runcorn, editor): London and New York, Wiley-Interscience, p. 47-51, 1969.

The 'big bang' theory of the origin of the Universe and the law of expansion of the Universe predict that the gravitational constant will decrease with age of the Universe. Egyed and Creer and other researchers have suggested that there is geological and geophysical evidence for a variable G. If data on length of day or month can be recovered from the geologic record as suggested by the daily, monthly, and annual growth increments discovered in corals by Wells (1963), Scrutton (1964), and Ma

(1958), then Dicke's method of using astronomical data to study changes of G can be used. At present there is no clear method of distinguishing between changes in I (Earth's moment of inertia) and in G. Differentiation is possible only if there are other growth increments dependent on another astronomical period of time such as that of the 18.6 yr precession of the nodes of the lunar orbit. — VSN

Rynn, John M. W. *See* Sbar, Marc L. 01973

09519 **Sahores, J. J.; Witherspoon, P. A.** Improved chromatographic method of analysing aqueous solutions of hydrocarbons [with French abs.]: Centre Recherche Pau Bull., v. 3, no. 2, p. 443-447, 1969.

The chromatographic analysis of very dilute (0.1-100 ppm) aqueous solutions of hydrocarbons can be significantly improved through careful control of temperature and composition of the carrier gas. The principal feature is a continual injection of pure liquid water at the sample injection point. An ethane-water solution can be analyzed with a precision of ± 0.3 percent. — Authors' abstract

Saint Amant, Marcel. *See* Gaucher, Edwin. 09473

09134 **Saint-Martin, H.** Zones de stockage du bassin versant, *in* Groundwater-streamflow systems — Canadian Natl. Comm. Hydrol. Decade and Laval Univ., Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, p. 19-32, illus., discussion [1969?].

This paper deals with parametric hydrologic methods of describing interrelationships of storage capacity, recharge, and discharge of ground-water and surface water in a drainage basin. A theoretical breakdown of the basin into storage zones shows their influence on distribution of discharge in time and space. Laws governing inflow and discharge are imprecise due to variance of the physical milieu of a zone. A hydrologic model of the rainfall-runoff relationship shows the contribution of storage zones to stream discharge and to the evaluation of ground-water reserves. The use of stream recession curves in estimating accumulation capacity of a basin is not definitive, as variables associated with aquifers intervene. These methods of estimating ground-water reserves are imprecise and can only be a verification of more precise exploration methods. — EH

Sakamoto, Koh. *See* Miller, Donald K. 01955

09561 **Salop, L. I.; Scheynmann, Yu. M.** Tectonic history and structures of platforms and shields, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 565-597, illus., 1969.

The term platform, a synonym of craton, is applied to any large portion of continental crust bounded by folded belts or sometimes by oceans, and characterized by tectonic stability over a very long period (several hundred million years or more), general tectonic homogeneity, and an absence of high gradients of movement. Shields are elements of platforms characterized by a tendency towards slow uplift over periods of hundreds of million years; they are not sharply delimited. The following ages are accepted for the upper boundaries of Precambrian units: Archean, 2600-2800 m.y.; lower Proterozoic, 2100 m.y.; middle Proterozoic, 1850-1650 m.y.; upper Proterozoic, 1100 m.y.; epi-Proterozoic, 620 m.y.; Eocambrian, 570 m.y. Material presented here is based mainly on Eurasian structures but results can be applied also to all other continents. — *from* Authors' abstract

01971 **Sammis, Charles G.** Elastic constants of lower mantle minerals from a lattice model [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

09267 **Sampson, Edward.** Stillwater, Montana chromite deposits — Discussion [of "Chemical variation in coexisting chromite and olivine in chromite zones of the Stillwater Complex," by E. D. Jackson, 1969], *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 72-75, illus., 1969.

Largest concentration of chromite in the Stillwater Complex is above Mountain View Lake in the Stillwater Valley where chromite layers alternate with harzburgite. Chromite seams are sharp at the bottom and gradational at the top with chromite showing variation in composition from high Cr_2O_3 at the bottom to lower grade at the top of the series. Pegmatitic material, generally present immediately beneath chrome layers in the Stillwater area, is characterized as compared to underlying rock by larger amounts of one or more of bronzite, plagioclase, diopside. Each pegmatite band is a concentration of the last mineral or minerals to crystallize in the underlying rock. Pegmatites are explained by a process of sweating out from underlying rock. Crystal settling is the predominant method of concentration of the chromite, but in a few places there is evidence of intrusion. — VSN

Sandberg, Charles A. *See* Macqueen, Roger W. 02155

Sanderson, G. A. *See* Verille, G. J. 02152

09250 **Sangster, D. F.** The contact metasomatic magnetite deposits of southwestern British Columbia [with French abs.]: Canada Geol. Survey Bull. 172, 85 p., illus., tables, geol. maps, 1969.

Ore zones, skarn, host rocks, and associated intrusions of twelve magnetite deposits were studied in field and laboratory to determine their mineralogical and geochemical characteristics, origin of the iron, and factors controlling emplacement of iron-bearing minerals. Skarn in coastal British Columbia is mainly garnet, pyroxene, epidote, and magnetite. Temperature of intrusion is estimated as 900-800°C, of skarnification as 800-450°C, and of iron formation as 600-500°C with confining pressure of 2,600 ± 1,000 bars. Most deposits replaced volcanic rocks near contact with limestone; several formed entirely in limestone. Local folds and faults are important physical controls; presence of limestone is a major chemical control. Immediate source of iron is believed to be nearby intrusions, and the ultimate source, the underlying volcanic rocks assimilated by plutons. Hydrothermal processes were solvate apposition, metasomatism, and cavity filling. — *from* Author's abstract

09156 **Santos, Elmer S.** Stratigraphy of the Morrison Formation and structure of the Ambrosia Lake district, New Mexico: U.S. Geol. Survey Bull. 1272-E, p. E1-E30, illus., 1969.

The Morrison Formation in the Ambrosia Lake district of northwestern New Mexico is divided into three members, which are, in ascending order, the Recapture, 125-245 feet thick; Westwater Canyon, 30-270 feet thick; and the Brushy Basin, 60-200 feet thick. Included in the Westwater Canyon Member is the Poison Canyon sandstone. Major structural elements are the McCartys syncline and the Ambrosia dome. These were broken by strike-slip faults during an early period of deformation and by normal faults during later deformation. All folds, with the possible exception of those in the Todilto Limestone, are post-Dakota in age. — ESS

Savage, J. C. *See* Pandit, B. I. 01965

01972 **Sayles, Fred L.; Manheim, Frank T.; Chan, Kwan M.** Pore water diagenesis in deep cores from the Atlantic [abs.]: EOS, v. 51, no. 4, p. 327, 1970.

01973 **Sbar, Marc L.; Rynn, John M. W.; Gumper, Frank J.; Lahr, John C.** An earthquake sequence and focal mechanism at Lake Hopatcong, northern New Jersey [abs.]: EOS, v. 51, no. 4, p. 352, 1970.

Scarbrough, W. Leon. *See* Joiner, Thomas J. 09510

02105 **Schafer, Charles; Brooke, John.** Cores from the crest of the Mid-Atlantic Ridge: Geotimes, v. 15, no. 3, p. 14-16, illus., table, 1970.

A new coring tool used to sample the crest of the Ridge near 45° N latitude is described. About 300 cm of igneous and sedimentary cores were collected, composed primarily of coralline limestone and/or basalt. Paleontologic and paleomagnetic analyses of these cores will enable geologists and geophysicists to test

hypotheses concerning the nature of magnetic anomalies on the Mid-Atlantic Ridge, and to clarify present ideas concerning the episodic nature of sea-floor spreading and continental drift. — ESL

Schairer, J. Frank. *See* Huckenholz, H. G. 09416

Scheidegger, A. E. *See* Thakur, T. 01989

09527 **Scheynmann, Yu. M.** Discussion of the paper "The origin of basaltic and nephelinitic magmas in the Earth's mantle" by D. H. Green, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 423-426, illus., 1969.

D. H. Green (ibid., p. 409-422) has stressed that in genesis and differentiation of basaltic magmas, differences in conditions of fusion of tholeiites, alkaline basalts, and even more alkaline magmas are determined by temperature differences in the source area. Possibilities for differentiation by a mechanism other than crystal settling are examined here. It is concluded that an effective molecular differentiation occurs in magma and leads to division of oxides so that in the higher temperature region, liquid is enriched in Si and Al, and in the colder region in alkalies and other bases. Rate of the process depends on temperature gradient; a first approximation indicates a drop of 200° over a distance of 1 km in 10^6-10^7 yr. Thus, in regions of magmatic differentiation and fusion, it is necessary to consider molecular differentiation and to expect different rocks in different parts of a reservoir. — VSN

Scheynmann, Yu. M. *See* Salop, L. I. 09561

Schindler, Peter. *See* Ghose, Subrata. 09406

Schiner, George R. *See* Kimmel, Grant E. 02125

02013 **Schloessin, H. H.; Beck, A. E.** On the pressure and temperature dependence of lattice thermal conductivity of enstatite, silica, and pyrophyllite [abs.]: EOS, v. 51, no. 4, p. 420, 1970.

01974 **Schneider, Eric D.** Deep sea diapiric structures [abs.]: EOS, v. 51, no. 4, p. 316, 1970.

Schneider, Eric D. *See* Vogt, Peter R. 09608

Schneider, William J. *See* Thomas, Harold E. 02035

09342 **Schnepfe, M. M.; Grimaldi, F. S.** Determination of palladium and platinum by atomic absorption: Talanta, v. 16, no. 5, p. 591-595, illus., table, 1969.

Palladium and platinum are determined by atomic absorption after fire-assay concentration into a gold bead. The limit of determination is about 0.06 ppm in a 20-g sample. Serious depressive interelement interferences are removed by buffering the solutions with a mixture of cadmium and copper sulfates with cadmium and copper concentrations each at 0.5 percent. Substantial amounts of Ag, Al, Au, Bi, Ca, Co, Cr, Fe, Hg, K, La, Mg, Mn, Mo, Na, Ni, Pb, Te, Ti, V, Y, Zn, and the platinum metals do not interfere in the atomic-absorption determination. — Authors' summary

Scholz, C. F. *See* Gumper, Frank J. 01918

09272 **Schopf, James M.** Systematics and nomenclature in palynology, [Chap.] 4 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 49-77, table, 1969.

Too many new names are currently being proposed for plant microfossils or palynomorphs. One causative factor is the difficulty in establishing identity between new and previously known materials; the stratigraphic significance of any taxonomic

group depends on accuracyof identity. To avoid excessive synonymy, a name should be established in accordance not only with actual rules of the International Code of Botanical Nomenclature, but also with the philosophy of phylogenetic taxonomy reflected by the Code. Phyletic considerations should take precedence in taxonomy over a wholly arbitrary system. Problems of species concept, phyletic diversity, convergence, conservatism, consistent values in higher taxa, organ genera, and morphologic systems are discussed. Eighteen annotated indexes or catalogs of plant microfossils are cited and evaluated as aids in taxonomic studies. — VMJ

09276 **Schopf, James M.** Precambrian microfossils, [Chap.] 9 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 145-161, illus., 1969.

Studies of origin and evolution of the earliest organisms, based on the vestigial fossil record of the Precambrian eras, are reviewed. Precambrian microfossils represent the long period of marine evolution before there was any life on land; evolution of the atmosphere interacted with that of the biota. Many Precambrian sporelike microfossils have been classed as phytoplankton, but contemporary fungal and holozoic organisms probably produced similar forms. Stratigraphic use of Precambrian microfossils is still in its beginning stages; isotopic dating of the rocks commonly provides the best age control. The oldest known are bacilliform and algalike microfossils from the Fig Tree cherts, South Africa, dated at about 3 b.y.; other dated occurrences are discussed. Problems in evaluating evidence for Precambrian fossils or biogenic structures are similar to those for extraterrestrial organized objects. — VMJ

09277 **Schopf, James M.** Early Paleozoic palynomorphs, [Chap.] 10 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 163-192, illus., 1969.

Studies of Cambrian to Silurian palynomorphs are reviewed. Early Cambrian forms resemble late Precambrian, but during the early Paleozoic, autotrophic planktonic algae increased and evolved rapidly, controlling the O_2-CO_2 balance of the atmosphere. Almost all represent spores of marine planktonic algae — dinoflagellate resting spores (including hystrichospheres), diacrodioids, acritarchs, and similar forms. Acritarchs, a grouping of uncertain affinities, probably can best be arranged in arbitrary groups of genera based on morphology; many may be dinoflagellate cysts. *Tasmanites*, common in Ordovician and younger deposits, are probably cysts of green algae closely related to living *Pachysphaera*. *Ambitosporites*, the oldest known trilete spores with functional sutures indicative of land plants, appear in the Lower Silurian of Libya. — VMJ

09257 **Schuster, Rudolf M.** Problems of antipodal distribution in lower land plants: Taxon, v. 18, no. 1, p. 46-91, illus., 1969.

Geographical distribution patterns of the leafy liverworts (subclass Jungermanniae of the Hepaticae) is interpreted in relation to distribution patterns of vascular plants and to geologic events. There is evidence that most major groups of Jungermanniae originated in Pananarctica (Gondwanaland), as the most primitive genera are endemic to the subantarctic region. Dispersal and disjunction patterns corroborate the theory of continental drift (Permian-early Tertiary). Many are cold-adapted types, which were displaced only slightly northward by late Tertiary and Pleistocene climatic deterioration, although some spread to the subarctic region along the Cordilleran and Australasian axes. Some more advanced types, predominantly bisexual, show bipolar distribution; these are probably of holarctic derivation, dispersed relatively recently to the subantarctic. — VMJ

Sclater, J. G. *See* Francheteau, Jean. 02197

01975 **Sclater, John G.; Francheteau, Jean.** Terrestrial heat flow observations and the plate theory of tectonics [abs.]: EOS, v. 51, no. 4, p. 330, 1970.

Scoates, R. F. J. *See* Kilburn, L. C. 09222

Scott, R. A. *See* Tschudy, R. H. 09337

Scott, Richard A. *See* Tschudy, Robert H. 09269

Seager, W. R. *See* Baars, D. L. 02073

01976 **Seeber, Leonardo; Barazangi, Muawia; Nowroozi, Ali A.** Seismicity and tectonics of coastal northern California [abs.]: EOS, v. 51, no. 4, p. 352, 1970.

02071 **Seeger, C. Ronald.** Geophysical investigations of the Versailles cryptoexplosion structure, and the Middlesboro Basin cryptoexplosion structure, Kentucky [abs.]: EOS, v. 51, no. 4, p. 342, 1970.

01876 **Shacklette, Hansford T.; Lakin, Hubert W.; Hubert, Arthur E.; Curtin, Gary C.** Absorption of gold by plants: U.S. Geol. Survey Bull. 1314-B, p. B1-B23, illus., tables, 1970.

Rooted plants, unrooted cuttings, and rooted bulbs were placed in sols and solutions of radioactive and nonradioactive gold; their absorption of gold sols, and solutions of gold chloride, cyanide, bromide, iodide, thiosulfate, thiocyanate, and of gold dissolved in cyanide that was derived from a cyanogenic plant, was measured by leaf autoradiographs and by atomic absorption analyses. Rooted plants did not absorb gold sols, and their absorption of gold chloride was prevented or limited by cell-induced precipitation of the gold. Although all the solutions were absorbed to some extent by the plants, gold cyanide was absorbed most readily and in the greatest amounts and is, moreover, a compound that could occur over gold deposits in soils that supported cyanogenic plants. — HTS

Sharp, B. J. *See* Austin, S. R. 02200

02146 **Shaw, Alan B.** Joint Committee on Paleontologic Information: Geotimes, v. 15, no. 3, p. 17-18, 1970.

During consideration of proposals for funding large computer-based systems for retrieval of paleontologic data, it became clear that no one of the existing societies was in a position to speak for the whole profession. About two years ago the presidents of SEPM and Society of Vertebrate Paleontology met with the president of the Paleontological Society, and it was recommended that a group to be known as the Joint Committee on Paleontologic Information be sponsored by these three societies. The organizing meeting was held in October 1968. The Committee is only an organ of the sponsoring societies, set up to supply them with background data on which governing councils can take action. To date there have been four task forces, on a census of paleontologists, on alternative publication media, on data filing and retrieval, and on objective descriptors. — ESL

02119 **Shaw, Herbert R.** Earth tides, global heat flow, and tectonics: Science, v. 168, no. 3935, p. 1084-1087, illus., table, 1970.

The power of a heat engine ignited by tidal energy can account for geologically reasonable rates of average magma production and sea-floor spreading. These rates control similarity of heat flux over continents and oceans because of an inverse relationship between respective depth intervals for mass transfer and consequent distributions of radiogenic heat production. — Author's abstract

Shaw, K. Wier. *See* Ross, Malcolm. 09501

09460 **Sheldon, Raymond Wilfred.** A universal grade scale for particulate materials: Geol. Soc. London Proc. 1969, no. 1659, p. 293-295, tables, 1969.

Logarithmic particle-size distribution is characteristic of many natural accumulations, but for measurements particles must be grouped. The form of a size-frequency distribution is sensitive to changes in scale; to compare results from different laboratories a standard scale is important, as are standard size class intervals. Based on geometric diameters, the Atterberg scale was adopted in Europe and the Wentworth scale in the United States and also in Britain. Logarithmic transformations proposed by Krumbein and Pettijohn are not strictly comparable, but easier for statistical

work: a ϕ scale (1934) physically identical to the Wentworth grades by a factor of 2, and a similar ζ scale (1938) for the Atterberg grades by a factor of 10. A grade scale based on particle volume for oceanographic work (Sheldon and Parsons, 1967) combines features of both binary and metric diameter scales; equivalent increments are compared. — GDC

09203 **Sheppard, Richard A.** Zeolites, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 464-467, illus., table, 1969.

Bedded zeolite deposits have been reported mainly from the west-central and southeastern parts of Arizona; the only other deposit reported is clinoptilolite in a bentonite at Dome. The deposits are listed and described briefly in a table. The bedded zeolites are potentially exploitable, but studies to determine their size and value await further industrial development and the establishment of suitable markets. — WLG

02076 **Shideler, Gerald L.** Provenance of Johns Valley boulders in late Paleozoic Ouachita facies, southeastern Oklahoma and southwestern Arkansas: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 789-806, illus., table, 1970.

The Johns Valley Shale is an integral part of the Late Paleozoic flysch sequence of the Ouachita mobile belt. In the central Ouachitas in a section 425 to 925 feet thick the formation, which is dominantly argillaceous, has a sequence of boulder-bearing beds which extend from Atoka County, Oklahoma to Scott County, Arkansas. The exotic clasts vary in age from Croixan (Cambrian) to Morrow (Pennsylvanian) age and vary in size from granules and pebbles up to blocks several tens of feet in diameter. Size distribution and age of the clasts suggest a source on a rising geanticlinal ridge, fault-bounded on the south, which became the locus of an emergent archipelago. — SEF

09233 **Shimeld, Dennis.** (editor). Groundwater-streamflow systems — Canadian Natl. Comm. Internat. Hydrol. Decade and Laval Univ. Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, 47 p., illus., table [1969?].

The five papers presented formally on the first day of the seminar are included in these proceedings; each is cited separately. — MCM

02204 **Shimp, Neil F.; Leland, Harry V.; White, W. Arthur.** Studies of Lake Michigan bottom sediments — No. 2, Distribution of major, minor, and trace constituents in unconsolidated sediments from southern Lake Michigan: Illinois Geol. Survey Environmental Geology Note 32, 19 p., illus., tables, 1970.

Preliminary results from study of chemical composition of southern Lake Michigan sediments indicate lead, bromine, zinc, nickel, and chromium accumulate in the upper few cm of deposits, where concentrations appear to be related to amount of organic carbon in the sediments. In deeper sediments most trace element concentrations increase as the amount of 2-micron clay increases. Two grab samples and four sediment cores analyzed were subjected to X-ray fluorescence, neutron activation, optical emission, atomic absorption, and wet chemical methods. Major constituents were Al, Si, Fe, Ca, Mg, K, Na, inorganic carbon, and organic carbon. Ti, Mn, P, and S were found in smaller amounts. Trace elements determined were B, Be, Br, Cd, Co, Cr, Cu, La, Ni, Pb, Sc, V, and Zn. Amounts of less than 2-micron clay, clay mineral composition, acidity, and oxidation-reduction potential also were determined in the sediments at appropriate depth intervals. — *from* Authors' abstract

02101 **Shindala, Adnan; Priest, Melville S.** The meandering of natural streams in alluvial materials: Water Resources Bull., v. 6, no. 2, p. 269-276, 1970.

Although there have been numerous publications which might be classified under the general subject of meanders, they have, for the most part, been preoccupied with the origin of meanders, helicoidal flow or the search for a characteristic or standard

meander. There seems to be little published information on the analysis of actual velocity patterns, the nature and role of bank caving or anomalies and differences in the geometry of bends. The purpose of this paper is to present a qualitative summary of current knowledge on the meandering of streams in alluvial materials, based upon a review of pertinent literature, data supplied by the Vicksburg and Little Rock Districts, Corps of Engineers, U.S. Army, and the observation of small-scale meanders on a tilting sand table. It is intended that this paper provide some coverage of the aspects of meandering that have hitherto been neglected. — Authors' abstract

02182 **Shive, Peter N.** Reply [to discussion by M. Fuller and W. Lowrie of "The effect of internal stress on the thermoremanence of nickel", 1969]: Jour. Geophys. Research, v. 75, no. 14, p. 2785-2786, 1970.

The paper discussed by Fuller and Lowrie (ibid., p. 2781-2783) was cited in *Abstracts of North American Geology* for February 1970. — DBV

09182 **Shride, A. F.** Asbestos, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 303-310, illus., 1969.

Asbestos has been mined from about 160 deposits and perhaps another 60-70 occurrences have been explored. Most of the deposits are in two areas in northern Gila County along the southern fringe of the Colorado Plateau where extensive remnants of the younger Precambrian strata are mostly flat lying. Eleven of the principal deposits are shown on a map and each deposit is described briefly. — WLG

01977 **Shuey, R. T.; Johnson, R. B.; Eardley, A. J.** Paleomagnetism of Lake Bonneville sediments [abs.]: EOS, v. 51, no. 4, p. 277, 1970.

Sibuet, Jean-Claude. *See* LePichon, Xavier. 01946

Sichler, Bertrand. *See* LePichon, Xavier. 01946

Silberman, M. L. *See* McKee, E. H. 02198

09592 **Silver, Leon T.** A geochronologic investigation of the anorthosite complex, Adirondack Mountains, New York, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 233-251, illus., table, 1968 [1969].

Cogenetic U-Pb isotope systems in zircons have been analyzed for five Adirondack anorthosites and compared with cogenetic charnockite from the Ticonderoga dome. The latter yields an interpreted zircon age of 1130 m.y., and zircon characteristics argue this to be the age of the host rocks. Petrological arguments of persistent spatial association and compositional gradations between the anorthosite and a suite ranging from norite to mangerite, syenite, quartz syenite, and granite imply that all these rocks are comagmatic. This leads to the conclusion that the age of the anorthosite itself is 1130 m.y. — *from* Author's abstract

Silverstein, Joel. *See* Abdel-Gawad, Monem. 01906

02017 **Simkin, Tom; Smith, J. V.** Minor-element distribution in olivine: Jour. Geology, v. 78, no. 3, p. 304-325, table, 1970.

Microprobe analyses of natural igneous olivines confirm that Ni increases and Mn decreases with increasing Mg content, and that crystal-chemical control is not overridden by effects resulting from pressure-temperature variations during crystallization. Ca ranges from 0 to 1 weight percent and does not correlate generally with major elements. Most plutonic olivines, however, have less than 0.1 percent Ca, whereas extrusive and hypabyssal olivines contain more than 0.1 percent. Depth of crystallization apparently determines Ca content. Highly undersaturated rocks contain olivine unusually high in Ca and Mn, yet low in Ni for any given Mg content. — *from* Author's abstract

Simmons, Gene. *See* Luth, W. C. 09579

01978 **Simpson, E. S.** On the dispersivity of real aquifers [abs.]: EOS, v. 51, no. 4, p. 284, 1970.

01979 **Simpson, J. W.; Strangway, D. W.** Stratigraphy in volcanic rocks of the Mogollon Plateau by K-Ar dating and paleomagnetism [abs.]: EOS, v. 51, no. 4, p. 271, 1970.

09258 **Skinner, Brian J.; Peck, Dallas L.** An immiscible sulfide melt from Hawaii, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 310-322, illus., tables, 1969.

Study of basaltic lava trapped in Alae pit crater from the August 1963 eruption of Kilauea volcano, Hawaii, indicates: (1) Immiscible sulfide-rich liquids separating from basic magmas are always FeS-rich and always contain a significant oxygen content. The oxygen content will appear as iron oxide, generally magnetite, in the cooled and crystallized sulfide mass. (2) Compositions of most sulfide-rich liquids are such that the first phase to crystallize is a copper- and nickel-rich pyrrhotite solid solution, leaving the remaining liquid progressively enriched in oxygen, depleted in Cu and Ni until its composition reaches a cotectic between pyrrhotite and magnetite when a pyrrhotite-magnetite mixture in approximate ratio 2:1 will crystallize. (3) Pyrrhotite solid solutions crystallizing from and coexisting with immiscible sulfide melts preferentially concentrate Cu and Ni, so early formed phases form the richest ore pockets. — *from* Authors' abstract

09358 **Skoch, Edwin J.; Britt, N. Wilson.** Monthly variation in phosphate and related chemicals found in the sediment in the island area of Lake Erie, 1967-68, with reference to samples collected in 1964, 1965, and 1966, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 325-340, illus., tables, 1969.

Sediment cores were sectioned at 2.5 cm intervals and each of the six sections was analyzed for total phosphate, iron, and organic carbon. There was a slight increase in phosphate since 1964; however, all three factors showed a definite increase from May 1967 through November 1968. Monthly variation was quite distinct and more severe than the differences between years. Two sampling methods yielded slightly different results. The sediment was found to consist of two distinct layers, with the upper 5 cm being usually higher in concentrations of materials than the lower portions. — *from* Authors' abstract

Škvor, Vladimir. *See* Kumpera, Otakar. 09251

02188 **Sleep, Norman H.; Biehler, Shawn.** Topography and tectonics at the intersections of fracture zones with central rifts: Jour. Geophys. Research, v. 75, no. 14, p. 2748-2752, illus., 1970.

Deep troughs with up to 2 km of relief occur at intersections of fracture zones with the central rift of midocean ridges. The cause of these depressions may be the loss of hydraulic head due to the viscosity of the material that upwells passively at ridges to produce a new sea floor. At such intersections the transform fault truncates the central rift, imposing an additional boundary to which the upwelling material tends to stick. More head loss and, therefore, a deeper rift are required for the material upwelling near the fault. Atlantic fracture zones may obtain their topography through a partial locking of the trough into the spreading sea floor. Pacific fracture zones have been affected by changes in spreading direction. Since a transform fault offsetting a rifted ridge may leak, more mapping is required to determine the principal cause of Atlantic fracture zones. — Authors' abstract

09215 **Sleeper, Elbert L.** Two new Cleoninae from the Rita Blanca Lake deposits (Coleoptera: Curculionidae), *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 131-133, 1969.

Cleonus (*Cleonidius*) *ritablancaensis* and *C.* (*C.*) *channingensis*, the first known cleoninid weevils from the Pleistocene of the United States, are described and illustrated. — HRC

01872 **Sliter, William V.** Inner-neritic Bolivinitidae from the eastern Pacific margin: Micropaleontology, v. 16, no. 2, p. 155-175, illus., 1970.

Eleven species of the foraminiferal family Bolivinitidae from the inner-neritic zone of the eastern Pacific off southern California and northwestern Mexico are examined and illustrated with the use of scanning electron microscopy. Taxonomic characters are redescribed, and morphologic variation is noted. — Author's abstract

09359 **Sly, P. G.** Sedimentological studies in the Niagara area of Lake Ontario, and in the area immediately north of the Bruce Peninsula in Georgian Bay, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 341-346, illus., 1969.

A study of the bottom sample variance in different environments in the Great Lakes was begun in 1967. By the end of 1969 two areas will have been completely surveyed: one around the Niagara River mouth in Lake Ontario, and the other in Georgian Bay, near the tip of the Bruce Peninsula. A preliminary study of a third area in Lake Ontario near Kingston, is to begin in 1969. A special sampling grid, covering an area of about 150 km^2 has been devised for use in all the study areas and sampling has been designed to yield material for sedimentological, geochemical and biological studies. Underwater photography has been used to provide visual records of the lake bottom. Echo sounding, side scan sonar, and continuous seismic profiling has been used to obtain subbottom penetration and complete physiographic coverage. — Author's abstract

01980 **Smart, J. S.** Computer simulations of Clinch Mountain drainage networks [abs.]: EOS, v. 51, no. 4, p. 278, 1970.

09475 **Smith, A. Y.; Dyck, W.** The application of radon methods to geochemical exploration for uranium [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 215, 1969.

02109 **Smith, Alan A.** The case for a procedure library in water resources [also French text]: Jour. Hydraulic Research, v. 8, no. 1, p. 89-108, illus., 1970.

Increasing use of computer techniques in hydraulics calls for a repository of programs, each couched in terms general enough to solve a wide range of related problems. Dangers are in: program packages not easily specified and complex documentation requiring too long to become familiar with coding and scope; hurried, inappropriate use without full understanding of analytical methods and assumptions; adjustment of problems to suit available programs; and considerable capital investment. Donated subroutines, each some basic frequently-recurring operation, easily defined, with simplified documentation in more than one language are desirable. Experience of specialists in engineering design and analysis is needed for a comprehensive framework of elementary problems, by careful selection of which more sophisticated procedures may be built. An appendix lists specifications for channel-flow problems with procedure diagrams. — GDC

Smith, C. H. *See* Irvine, T. N. 09220

Smith, C. H. *See* Delany, F. 09558

01981 **Smith, Carl W.; Murri, William J.; Petersen, Carl F.** Release adiabats of selected quartz rocks [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

09466 **Smith, Donald E.; Murthy, M. K.** Silica-kaolin deposits of Algocen Mines Limited, Missinaibi River area, District of Cochrane, Ontario [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 197, 1969.

Smith, J. V. *See* Simkim, Tom. 02017

09404 **Smith, J. V.** Crystal structure and stability of the $MgSiO_3$ polymorphs: physical properties and phase relations of Mg, Fe pyroxenes, *in* Pyroxenes and amphiboles—

Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 3-29, illus., tables, 1969.

Crystal structure and phase relations of the enstatite-ferrosilite series are examined in detail. The X-ray powder diffraction pattern of high clinoenstatite is reindexed as a monoclinic cell with a large cell volume and long *c* repeat. The atomic nature of transformations between polymorphs is discussed in terms of "autoepitaxy" with possible retention of some Mg-O bonds and all Si-O bonds. The high pressure-low temperature transformation of ortho- into clinoenstatite is regarded as a nonequilibrium process. At low temperatures, stress nucleation of clinoenstatite is believed to be rapid enough to overcome recrystallization back to the ortho form. Kinetically, clinoenstatite is a stress mineral. Volcanic orthopyroxenes yield larger cell volumes than plutonic and metamorphic ones. Enstatite-ferrosilite is divided into two series at Fs_{50}. — *from* Author's abstract

Smith, L. A. *See* Newell, N. D. 09451

01982 **Smith, Robert B.; Mikulich, Matthew J.; Wold, Richard J.** Great Salt Lake seismic reflection survey, preliminary results [abs.]: EOS, v. 51, no. 4, p. 355, 1970.

09221 **Snyder, Frank G.** Precambrian iron deposits in Missouri, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 231-238, illus., tables, 1969.

The ten known iron occurrences in southeastern Missouri include three major deposits [Iron and Pilot Knobs, and Iron Mtn.]. The ore is magnetite with minor hematite in Precambrian rhyolites and andesites, and mineralization may be conformable with volcanic flow structures or sharply disconformable. Ore bodies, overlain by up to 2,000 feet of Lower Paleozoic sediments, may be at the Precambrian outcrop or subcrop, or within upper Precambrian; their presence is indicated by strong sharp magnetic anomalies. Ages of rocks from Missouri range from 1.1 b.y. to 1.5 b.y. At Pea Ridge ore body, the rhyolite host and post-ore dike cutting the ore body give essentially the same age of 1.3 b.y. Deformation due to magmatic pressure that accompanied or immediately followed igneous activity is believed the major factor in localizing deposits. Evidence suggests derivation of iron from granitic magma differentiation. — *from* Author's abstract

02179 **Sobczak, L. W.; Weber, J. R.; Roots, E. F.** Rock densities in the Queen Elizabeth Islands, Northwest Territories: Geol. Assoc. Canada Proc., v. 21, p. 5-14, illus., tables, 1970.

Results of 1900 density measurements of crystalline, carbonate, and clastic rocks from Queen Elizabeth Islands are presented graphically and in tables. Data were compiled directly from sampling of surface rocks and rock material from drill-holes, and indirectly by relating densities to seismic velocities and from detailed gravity profiles across topographic features. The weighted mean densities of Precambrian crystalline rocks, and of Paleozoic carbonate rocks of the Franklinian miogeosyncline and Arctic Lowlands are each 2.76 g/cm^3. Paleozoic evaporite rocks have a weighted mean density of 2.56 g/cm^3. Franklinian clastic rocks exhibit a range of density, in part apparently related to age and/or depth of burial; Silurian clastics have a weighted mean density of 2.62 g/cm^3 and Devonian 2.51 g/cm^3. In contrast, Mesozoic clastic rocks of Sverdrup basin have a weighted mean density of 2.32 g/cm^3. — *from* Authors' abstract

02191 **Soc. Prof. Well Log Analysts.** Transactions of the SPWLA 11th annual logging symposium, Los Angeles, Calif., 1970: Houston, Tex., Soc. Prof. Well Log Analysts, papers paged separately, illus., tables, 1970.

Of the 15 papers presented at this symposium held in May 1970, 13 are cited separately. — MCM

09375 **Sonu, Choule J.** Collective movement of sediment in littoral environment, Chap. 24 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 373-400, illus., 1969; *reprinted as* Louisiana State Univ. Coastal Studies Inst. Tech. Rept. 71, 1969.

Bar-type sand waves move only in the onshore direction and account for various accretive profiles on the subaerial beach. When the beach is eroded, these sand waves are simply disintegrated on the subaerial beach, instead of migrating back in the form of sand waves. These characteristics of bar-type sand waves help explain dynamic behavior of beach profiles with respect to profile configuration, sediment storage, and beach width. Cusp-type sand waves are considered to be a product of interaction between longshore currents and an erodible bed. Their presence causes variability in beach profiles along the shore between those containing a prominent bar and those without a bar. Migration of these sand waves may well produce pulsational transfer of material along the shore. — *from* Author's abstract

Soot-Ryen, T. *See* Newell, N. D. 09447

09424 **Sorensen, Robert M.** Recession of marine terraces, with special reference to the coastal area north of Santa Cruz, California, Chap. 42 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 653-670, illus., 1969.

The accepted history of sea level since the last glacial maximum, particularly during the last 7,000 years, is reviewed as well as pertinent information on the geology, topography, and wave climate of the study area. It is then shown that the average recession rates estimated by relating extrapolated bedrock profiles of the lowest marine terraces with the accepted history of the latest sea level rise compare favorably with the recently measured recession rates. However, a conflict exists between the present wave-cut terrace profiles, the accepted history of sea level, and the accepted value of wave base. — *from* Author's abstract

09259 **Souch, B. E.; Podolsky, T.; Internat. Nickel Company of Canada.** The sulfide ores of Sudbury, their particular relationship to a distinctive inclusion-bearing facies of the nickel irruptive, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 252-261, illus., tables, 1969.

Gross aspects of the Sudbury ore deposits supplemented by observations on structure, geochronology, and petrology of the nickel irruptive have revealed intimate linkages relating the many ore types to each other and to the irruptive. Ores are sulfide-rich portions of a discontinuous noritic 'sublayer' at the base of the irruptive, seemingly introduced as an inclusion, and sulfur-rich silicate magma. Ore mineral ratios vary unpredictably from mine to mine, but in any given body show a predictable zoning trend toward the footwall. No zoning related to depth alone has been recognized. Isotope dates suggest that the norite and sublayer may be contemporaneous but older than the micropegmatite. Modal analyses of samples from traverses across the norite into micropegmatite show gradual and abrupt variations. Nickel, copper, and sulfur contents in norite increase toward its base but are an order of magnitude less than in average sublayer rock. — *from* Author's abstract

02117 **Speight, J. G.** A structural investigation of the constituents of Athabasca bitumen by proton magnetic resonance spectroscopy: Fuel, v. 49, no. 1, p. 76-90, illus., tables, 1970.

A structural investigation has been made of the constituents of the Athabasca bitumen by proton magnetic resonance spectroscopy. The chemical structures within the bitumen are expressed in terms of carbon-type distribution which is derived from proton distribution, elemental analyses, and molecular weight data. An estimate has been made of the structure of the aromatics within the fractions by determining the peripheral and internal aromatic carbon atoms and relating ratios of peripheral aromatic carbons to total aromatic carbons to those of known fused ring compounds. — Author's abstract

02027 **Spieker, Andrew M.** Water in urban planning, Salt Creek basin, Illinois — Water management as related to alternative land-use practices: U.S. Geol. Survey Water-Supply Paper 2002, 147 p., illus., tables, 1970.

The study in water management in Salt Creek basin, Chicago metropolitan area, concentrates on related problems of ground-water recharge, water quality, management

of flood plains, and flood-control measures. Nearly all public water supplies depend on ground water; of total pumpage of 27.5 mgd, 17.5 mgd is pumped from the deep Cambrian-Ordovician aquifers and 10 mgd from the shallow Silurian dolomite and glacial drift aquifers. Potential yield of the latter far exceeds present use. Preservation of effectiveness of potential recharge areas should be considered in land-use planning. Possible solutions to problems of creek pollution and overbank flooding are offered. Present development trends threaten to consume most undeveloped land and to continue pressures for further development of the flood plains. Better water-management opportunities are offered in comprehensive plans which provide for preservation of additional open space. — *from* Author's abstract

Spiess, Fred N. *See* Larson, Roger L. 01944

Sproule, J. C. *See* Layer, D. B. 02161

Srinivasan, B. *See* Alexander, E. C., Jr. 02066

09256 **Srivastava, Satish K.** *Mtchedlishvilia canadiana* gen. et sp. nov. from the Edmonton Formation (Maestrichtian), Alberta, Canada: Pollen et Spores, v. 11, no. 3, p. 616-618, illus., 1969.

Mtchedlishvilia, n.gen., is diagnosed as a form genus of tricolpate angiosperm pollen with three well-developed equatorial projections, no polar projection, and very short polar axis. The type species, *M. canadiana*, n.sp., has been found in the lower and middle members of the Upper Cretaceous Edmonton Formation near Drumheller, Alberta. *Tricerapollis glaber* Chlonova, 1961, from the Upper Cretaceous of the Western Siberian depression, is herein referred to *Mtchedlishvilia*; it is smooth, whereas *M. canadiana* has reticulate ornamentation and spinules on the apices. Botanical affinities with modern plants are uncertain. — VMJ

Staatz, M. H. *See* Adams, J. W. 09175

Stanley, Alan. *See* Östrem, Gunnar. 09139

01983 **Steiner, Maureen B.** Jurassic, a period of rapid polar wander, continental drift [abs.]: EOS, v. 51, no. 4, p. 272, 1970.

09384 **Stephens, F. R.** Source of cation exchange capacity and water retention in southeast Alaskan spodosols: Soil Sci., v. 108, no. 6, p. 429-431, tables, 1969.

The colloidal organic and iron compounds are so active they completely mash the effect of the limited amounts of alumino-silicate clay in these soils. This is evidence that the clay content is so poorly correlated with the cation exchange capacity. The alumino-silicate clays either do not form or are leached out in the profiles in this cool, wet climate. — JWH

01984 **Stesky, R. M.; Strangway, D. W.** Magnetic studies of deep sea cores from the Mid-Atlantic Ridge [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

09360 **Stevenson, Anne L.; Benninghoff, William S.** Late post-glacial rise of Lake Erie and changes in vegetation on the Maumee Lake Plain, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 347-350, illus., 1969.

A 2 m long core with a buried forest layer at the base was recovered from South Bass Island in Lake Erie. Coniferous wood yielded a C-14 age of 2500 ± 270 yrs B.P. The 5 cm-thick layer recovered from the forest soil contains dicotyledonous wood, broad-leaved tree tissue, and abundant fungus mycelia in a matrix of subaerially decayed black amorphous muck. The forest bed is successively overlain by fibrous peat, pond ooze, and allochthonous detrital peat. If the pond basin has not subsided due to subsurface gypsum solution, a lake level rise of at least 3 m since 550 B.C. is indicated. It is probable that this dated evidence for relatively recent rise in lake level is causally linked with extension of wet soils and hydric plant communities on portions of the

Maumee Lake plain through the raising of stream base levels. — *from* Authors' abstract

09136 **Stevenson, D. R.; Davis, D. A.** Measurement, tracing and analysis of groundwater-streamflow systems, *in* Groundwater-streamflow systems — Canadian Natl. Comm. Hydrol. Decade and Laval Univ., Workshop Seminar, 1967, Proc.: Ottawa, Ontario, Canadian Natl. Comm. Internat. Hydrol. Decade, p. 37-46, illus., discussion [1969?].

The types of chemical and radioactive tracers commonly used in watershed tracing and dating projects are listed, advantages and disadvantages discussed, and previous work described. Models of the analog, digital and physical types applicable to the study of the interaction of water and the surrounding media are discussed. A section on hydrograph analysis as a tool in separation of flow components is also included. — Authors' abstract

09361 **Stieglitz, Ronald D.** A study of freshwater sand grain surfaces by scanning electron microscopy, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 351-356, illus., 1969.

Samples, taken from a small lake in Door County, Wis., Lake Michigan beaches and dunes in Door County, and the Indiana dunes, were studied by scanning electron microscope. Results indicate that textures may be distinctive and add much information about physical and chemical conditions in the depositional environment. Several quartz grains were etched in hydrofluoric acid for periods of 5 to 15 min to study the effects of chemical attack and crystallographic control on surface textures. — *from* Author's abstract

09149 **Stoddart, D. R.** Ecology and morphology of Recent coral reefs: Cambridge Philos. Soc. Biol. Rev., v. 44, no. 4, p. 433-498, illus., tables, 1969.

Studies of coral reefs are reviewed; Darwin's (1842) subsidence theory and Daly's (1910-1948) glacial control theory of reef development are evaluated. Whereas the classical "coral-reef problem" concerned geological relationships, modern studies consider reefs both as complex biological systems and as geological structures forming a framework for and being modified by coral growth. Reefs are discussed as ecosystems: by functional aspects, including ecological controls, catastrophic mortality; and by morphological aspects, including types of reefs, zonation, growth rates of corals and reefs. Effects of Quaternary sea-level changes on present reef topography are considered. Lastly, reefs are discussed as geologic frameworks of sedimentation. Reefs as geological systems adjust to changes much more slowly than as biological systems; because of the magnitude and recency of Pleistocene sea-level fluctuations, many biological features of reefs are out of phase with inherited geological features. — VMJ

Strangway, D. W. *See* Simpson, J. W. 01979

Strangway, D. W. *See* Stesky, R. M. 01984

09330 **Strong, Emory.** Early accounts of the eruption of Mt. St. Helens: Geol. Soc. Oregon Country Geol. News Letter, v. 35, no. 1, p. 3-5, 1969.

Mount St. Helens is a perfectly formed truncated cone resting on a base of probable Eocene sediments, folded in Miocene time. The earliest recorded activity was in 1831, with another mentioned in 1835, and a great outburst in 1842 recorded by several explorers; sporadic activity continued for 10 more years. The eruptions came from a point about one-third of the way down the cone. Indians report that there were once three mountains that smoked continually, St. Helens, Mount Hood, and Mount Adams. — ESL

Stroyev, P. A. *See* Gaynanov, A. G. 09154

01985 **Stuart, William D.** Bermuda gravity anomalies and pedestal evolution [abs.]: EOS, v. 51, no. 4, p. 316, 1970.

09174 **Stubbs, F. L.** Platinum-group metals, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 243-244, 1969.

Only a few doubtful occurrences of platinum-group metals have been reported in Arizona, and the potential is poor. Two small peridotite bodies occur in association with other lower Precambrian rocks in northeastern Maricopa County, but no platinum-group metals have been found in them. — WLG

09371 **Stuiver, Minze; Purpura, J. A.** Application of fluorescent coated sand in littoral drift and inlet studies, Chap. 19 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 307-321, illus., tables, 1969.

The use of fluorescent coated sand in tracing the sand movement along beaches and around inlets is an important tool in the field of coastal engineering. As a part of an extensive beach erosion study along the shore of West Palm Beach, Florida, four areas were subjected to such a "tracer study." Each area represented a particular beach configuration either with or without erosion protective structures. In this paper the procedure and results for one area is described. As a second application of sand tracers, the results of a study concerned with the sand migration in and around South Lake Worth Inlet is discussed. — Author's abstract

09213 **Sublette, James E.** Aquatic insects of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 117-122, table, 1969.

Insects referable to six families (one with three subfamilies) are discussed. The insects accumulated as a thanatocenose in the deep part of the lake by transport from overlying mixolimnion, not from animals living *in situ* , as indicated by the presence of only a single larval head capsule in the collection, and the fact that very delicate exhuvae form the bulk of the remains. These could persist only in the absence of macroscopic life on the profundal lake floor and in the absence of water circulation. — HRC

Summers, A. L. *See* Fricker, P. E. 01883

09433 **Sutherland, Jeffrey C.** Geochemical systems in Onondaga Lake (central New York State) compared with the Great Lakes, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 357-363, illus., 1969.

Onondaga Lake (22 m deep) is eutrophic and unusually high in dissolved Ca^{+2}, Na^{+}, Cl^{-}, SiO_2, and PO_{40}^{-3}-P. Interpretations of chemical and mineralogic data in equilibrium models are compared with those for the Great Lakes. Near equilibrium with calcite and dolomite is inherited from influent streams. Erie is in equilibrium with hydroxyapatite, but Onondaga Lake is oversaturated. Lower limits of SiO_2 in Huron are established by dissolution of kaolinite, whereas upper limits in Onondaga may be partly prescribed by reaction of kaolinite to form K feldspar. Silica in North Channel of Huron and Onondaga approaches equilibrium with amorphous silica as upper limits. Equlibrium between montmorillonite and kaolinite may depend upon ratios of Ca to Na, among other factors. — *from* Author's abstract

Sutherland, Joyce. *See* Davis, Ronald B. 09253

09363 **Sutherland, Patrick K.; Haugh, Bruce N.** The discoid rugose coral *Gymnophyllum*, growth form and morphology, *in* Stratigraphy and palaeontology — Essays in honour of Dorothy Hill (K. S. W. Campbell, editor): Canberra, Australian Natl. Univ. Press, p. 27-42, illus., 1969.

Gymnophyllum wardi Howell, youngest and one of the largest discoid rugose corals known, and locally abundant in the Middle Pennsylvanian Wewoka Formation, eastern Oklahoma, is believed to have been adapted for life on a muddy sea bottom. Discoid corallites with radial arrangement of septa increased in size by outward expansion in a horizontal plane. New major and minor septa in the normal rugose inser-

tion pattern do not fully compensate for divergence of the septa as they lengthen. In *Gymnophyllum wardi* peripheral gaps are partly filled by insertion of minor septa, peripheral splitting of the cardinal and counter septa, and addition of third-order septa. Apparent limitations placed on this growth form by the rugose insertion mechanism may account for the small size of all known rugose corals with discoid shape and the rarity of such corals in the fossil record. — GDC

09295 **Suttle, A. D., Jr.; O'Brien, Barbara C.; Mueller, D. W.** Neutron activation analysis of uranium in geological material by measuring tellurium-132: Anal. Chemistry, v. 41, no. 10, p. 1265-1269, illus., tablestables, 1969.

A simple and sensitive method has been developed for determining submicrogram quantities of uranium in geological material using neutron activation. A fission product of U-235, Te-132, is separated radiochemically from the irradiated sample, determined by gamma spectrometry, and related to the uranium concentration of the original material. The radiochemically separated Te-132 emits a high intensity gamma ray at 230 keV which is free from interference from any other radionuclide. Under existing irradiation conditions (3×10^{12} n $cm^{-2}sec^{-1}$ for 10 hours), 50 nanograms of uranium can be determined with a precision of +3.5 percent. The proposed method has the advantages of precise determination of submicrogram and microgram quantities of uranium in geological samples with a minimum of specialized equipment. — Authors' abstract

Suttle, A. D., Jr. *See* Albu-Yaron, Ana. 09298

09514 **Swadley, W. C.** Geologic map of parts of the Patriot and Florence quadrangles, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-846, scale 1:24,000, text, 1969.

Sand and gravel are excavated in these parts of the Patriot and Florence quadrangle for aggregate and road metal; a small quarry has yielded limestone from the Point Pleasant Formation for riprap and fill for local construction projects. Wells drilled in valley bottoms yield water at a rate of 100-500 gpd, those in alluvium and outwash along the Ohio River, up to 500 gpm; ground water generally is hard to very hard. As shale of the Kope Formation slumps readily when wet, structures should have adequate drainage and oversteepened slopes should be avoided. — MCM

01881 **Sweeney, John W.; Hasslacher, Robert N.** The phosphate industry in the southeastern United States and its relationship to world mineral fertilizer demand: U.S. Bur. Mines Inf. Circ. 8459, 76 p., illus., tables, 1970.

Almost all of the phosphate rock produced in the U.S., and a large part of the world's production comes from three southeastern states — Florida, Tennessee, and North Carolina. Resources estimated at 4,615 million short tons of greater than 60 percent BPL (bone phosphate of lime = percent $P_2O_5 \times 2.185$) phosphate rock containing 1,424 million short tons of P_2O_5 are ample to supply domestic and export requirements at the projected rates of consumption well beyond the year 2000. Deposits and technology are described by state. — VPB

01986 **Syed, Atiq A.; Nuttli, Otto W.** Effects of earthquake source mechanism on P wave amplitude [abs.]: EOS, v. 51, no. 4, p. 358, 1970.

09292 **Sykes, C. Ronald.** Mineral resources summary of the Palmyra quadrangle, Tennessee: Nashville, Tenn., Tennessee Div. Geology, 9 p., 1969.

Mineral resources mined in the Palmyra quadrangle include small deposits of iron ore from hills and hill slopes and generally enclosed in residuum derived by weathering of the St. Louis and Warsaw Limestones, and limestone mainly from the Warsaw Limestone. Chert is a potential resource. — MCM

09552 **Sykes, J. Oliver; Isacks, B.** Seismology and the new global tectonics, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 527-541, illus., 1969.

Seismologic observations provide widely based support for the new global tectonics founded on hypotheses of continental drift, sea-floor spreading, transform faults, and underthrusting of the lithosphere on island arcs. Seismic phenomena are explained as the result of interactions and other processes at or near edges of a few large mobile plates of lithosphere that spread apart at ocean ridges where new surficial materials arise, slide past one another along large strike-slip faults, and converge at island arcs where surficial materials descend. World seismicity shows that most earthquakes are confined to narrow continuous belts bounding large stable areas. In zones of divergence, activity is moderate and shallow; in zones of convergence, activity is shallow but includes intermediate and deep shocks that grossly define the configuration of downgoing slabs of lithosphere. Lengths of deep seismic zones appear to be measures of the amount of underthrusting during the last 10 m.y. — *from* Authors' abstract

Sykes, Lynn R. *See* Murphy, Andrew J. 01956

Takahashi, T. *See* Liu, L. G. 01949

Takahashi, Taro. *See* Hammond, Douglas E. 02012

09382 **Tandon, H. L. S.** Fluoride-extractable aluminum in soils — [Pt.] 1, Its relation to fluoride-extractable phosphorus: Soil Sci., v. 108, no. 6, p. 397-401, illus., tables, 1969.

At least one-fourth of fluoride-extractable P and Al extracted in 160 minutes was extracted in the first minute. The initial rate of extraction was inversely proportional to the amount of clay in the soil. — JWH

Tappan, Helen. *See* Loeblich, Alfred R., Jr. 02144

09262 **Taylor, Hugh P., Jr.; Noble, James A.** Origin of magnetite in the zoned ultramafic complexes of southeastern Alaska, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 209-230, illus., tables, 1969.

Concentrations of titaniferous magnetite occur in several ultramafic complexes exposed along a 350-mi linear belt in southeastern Alaska; bodies at Klukwan, Snettisham, Union Bay, and Duke Island are of economic interest. Large magnetite concentrations of very uniform grade occur in hornblende pyroxenite units of these complexes. In several complexes consistent zoning of ultramafic rock types occurs, with dunite, peridotite, olivine pyroxenite, and hornblende pyroxenite occurring in sequence from center to margin. Mineralogy of the hornblende pyroxenite zone is identical in all complexes: diopsidic augite, hornblende, magnetite, and accessory ilmenite and hercynitic spinel. The common features [given here] of these ultramafic bodies indicate they formed by a single mechanism, namely by crystallization of ultramafic magmas. — *from* Authors' abstract

09585 **Taylor, Hugh P., Jr.** Oxygen isotope studies of anorthosites, with particular reference to the origin of bodies in the Adirondack Mountains, New York, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 111-134, illus., tables, 1968 [1969].

The O-18:O-16 ratios for plagioclase from many anorthosite bodies throughout the world are very similar with δ-values of 5.8 to 7.6 per mil relative to standard ocean water. This is identical to the range in plagioclase from basalt and gabbro. The anorthosite bodies of the Adirondacks have been metamorphosed intensively and also have considerably higher O-18:O-16 ratios (8.9 to 11.2 per mil). Most of the meta-igneous rock types of the Adirondacks are enriched in O-18 relative to their unmetamorphosed counterparts in other localities; therefore, a large fraction of the present Adirondack terrane cannot have been a closed system during metamorphism. — *from* Author's abstract

01987 **Taylor, P. T.; Wall, R. E.** Sediment structure associated with the GILLISS Seamount, New England Seamount chain [abs.]: EOS, v. 51, no. 4, p. 334, 1970.

01988 **Taylor, P. T.; O'Neill, N. J.; Brennan, J. A.** Aeromagnetic data west of Baja California and across the lower California rift system [abs.]: EOS, v. 51, no. 4, p. 275, 1970.

01874 **Taylor, Thomas N.** The morphology of *Bowmanites dawsoni* spores: Micropaleontology, v. 16, no. 2, p. 243-248, illus., 1970.

Spores of the Paleozoic sphenophyllalean cone *Bowmanites dawsoni* are described. Morphological and structural features are determined by utilizing the combined information from light microscopy and transmission and scanning electron microscopy. — Author's abstract

Taylor, Thomas N. *See* Good, Charles W. 02022

09315 **Teague, Kefton H.** Evaluation of feldspar deposits [abs.]: Econ. Geology, v. 64, no. 8, p. 938, 1969.

Tera, F. *See* Eugster, O. 02137

09551 **Texas A and M University.** (Activation Analysis Research Lab.). 14-MeV neutron activation analysis of selected Leg 1 core samples, *in* Initial reports of the Deep Sea Drilling Project — V. 1, Leg 1 of cruises of *Glomar Challenger*, Orange, Tex., to Hoboken, N. J., Aug.-Sept. 1968: Washington, D. C., U.S. Govt. Printing Office, p. 368, table [1969?].

Each sample and standard was irradiated with 14 MeV neutrons for two minutes, counted for two and ten minutes after cooling times of ten minutes and two hours respectively. A weighted least-squares computer program utilizing the information contained in the two spectra was used to resolve radioactivity from activation products of Si, Al, Fe, and Mg and to compute the amount of each present. Oxygen content was determined by a separate procedure. — ESL

01989 **Thakur, T.; Scheidegger, A. E.** Chain model of river meanders [abs.]: EOS, v. 51, no. 4, p. 278, 1970.

01990 **Thatcher, Wayne.** An oceanic ridge earthquake swarm, northern Gulf of California, March 1969 [abs.]: EOS, v. 51, no. 4, p. 357, 1970.

09261 **Thayer, T. P.** Gravity differentiation and magmatic re-emplacement of podiform chromite deposits, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 132-146, illus., table, 1969.

Relict cumulate features preserved in podiform chromite deposits include some textures found in stratiform complexes and, in addition, nodular and orbicular textures. In most podiform deposits relict textures have been modified or destroyed by flowage at magmatic temperatures. These chromitites are believed to have formed as layers in supercomplexes analogous to those known to have produced stratiform type chromitite by gravitational differentiation of fluid magma in the upper mantle. Layered differentiates appear to have been re-emplaced into the crust as hot crystal mushes, during which chromite was solid and relatively rigid compared to olivine, pyroxene, and plagioclase which yielded more or less plastically. Some interstitial magma formed dilation dikes. Random distribution of gabbro and peridotite in many alpine complexes and erratic compositional variation of chromite in neighboring deposits indicate mixing of various differentiates during re-emplacement. — *from* Author's abstract

09531 **Thayer, T. P.** Alpine-type sensu strictu (ophiolitic) peridotites — Refractory residues from partial melting or igneous sediments, a contribution to the discussion of the paper "The origin of ultramafic and ultrabasic rocks" by P. J. Wyllie, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 511-516, 1969.

Although alpine peridotites and basaltic lavas are widely associated in eugeosynclines and oceanic areas, their genetic ties are obscure. Three major characteristics of olivine-rich alpine peridotite and dunite — relict cumulus textures, aggregated masses of chromitite, and intimate association with magnesium-rich gabbro — cannot be explained by partial melting of garnet peridotite to form tholeiite. As-

sociation of magnesium-rich gabbro with the chromite-bearing and so-called high-temperature alpine peridotites is believed to present problems that have not been considered by advocates of the partial-melting hypothesis. The chromite-bearing alpine peridotites and related feldspathic rocks are believed to have formed near the top of the mantle by gravitational differentiation processes which are largely independent of the melting processes that produce basaltic magma at depths of 50 km or more. — Author's summary

Thomas, C. A. *See* Norvitch, R. F. 09516

02035 **Thomas, Harold E.; Schneider, William J.** Water as an urban resource and nuisance: U.S. Geol. Survey Circ. 601-D, p. D1-D9, 1970.

Water is subject to natural variations in quantity and quality both in time and place. Many urban activities concerned with development and use of land and its resources other than water affect the natural water flow system and are affected by it. In urbanized areas, water as a resource becomes increasingly inadequate to meet requirements; nonconsumptively used waters contribute pollutants to natural water resources. Urbanization causes some drastic changes in the natural hydrologic system and changes the hydrology of an area profoundly. Urban planners are becoming aware that decisions for today based upon expediency may result in problems for tomorrow that may be costly or even impossible to solve. The urban water problem is a part of the ever-growing national water problem which can be solved only if a complete understanding of the role of water in the urban environment is realized. — *from* Authors' summary

09438 **Thomas, Richard L.** The qualitative distribution of feldspars in surficial bottom sediments from Lake Ontario, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 364-379, illus., tables, 1969.

A qualitative assessment of feldspar distribution in Lake Ontario sediments was made by determination of feldspar end members, K, Na, Ca on sediment residues after fusion with K-pyrosulfate. Cation exchange is shown to be minimal in samples and standards with a full particle size range. K adsorption is high but is constant and not related to size. Inshore, a poor positive correlation of feldspar to quartz is believed to be the result of poor mixing in traction load sediment. In the basins the relationship is of a higher order and reflects natural sorting by sedimentation from the suspended load. Regionally, feldspar decreases inshore to offshore, initially of Ca, then Na feldspar, and leading to basin enrichment of K feldspars. The feldspars are probably derived predominantly by coast line erosion of glacial deposits around the lake. — *from* Author's abstract

09489 **Thompkins, R. W.; Cheng, Ku-Chuan.** The measurement of radon emanation rates in a Canadian uranium mine: Canadian Mining and Metall. Bull., v. 62, no. 692, p. 1356-1362, illus., tables, 1969.

Radon gas emanates into uranium mines from the rock walls or from the faces of broken ore lying in the stope. It is the source of the radon daughters, which in turn are the elements that produce physiological damage in the lungs and which are the source of the definition of a working level of radiation. Knowledge of the rate of emanation is essential to the design of mine ventilation systems for uranium mines. This paper describes the method being used at Elliot Lake to measure the emanation of radon gas. — Authors' abstract

02162 **Thompson, Alan Bruce.** A note on the kaolinite-pyrophyllite equilibrium: Am. Jour. Sci., v. 268, no. 5, p. 454-458, illus., table, 1970.

An attempt has been made to find the equilibrium conditions for the reaction: kaolinite + quartz = pyrophyllite + H_2O by studying the weight-change of quartz crystals in the presence of fine-grained powdered kaolinite plus pyrophyllite and excess water. The data suggest equilibrium at 325° ± 20°C at 1 kb, 345° ± 10°C at 2 kb, and 375° ± 15°C at 4 kb (water pressure = total pressure). — *from* Author's abstract

Thompson, Don S. *See* Boone, Gary M. 09600

02025 **Thompson, Geoffrey; Melson, William G.** Boron contents of serpentinites and metabasalts in the oceanic crust, implications for the boron cycle in the oceans: Earth and Planetary Sci. Letters, v. 8, no. 1, p. 61-65, illus., tables, 1970.

Serpentinization of peridotite rocks in the oceanic crust is accompanied by boron enrichment. Hydrothermallly altered basalts in the oceanic crust show no comparable increase in boron. In high-temperature reactions of basaltic rocks and sea-water, boron is preferentially partitioned into the liquid phase; basaltic rocks exposed on the ocean floor undergo low-temperature weathering by sea-water resulting in the addition of boron. Juvenile boron-containing solutions may be responsible for serpentinization. Such solutions may also be important in maintaining the boron concentration of the oceans, since boron is removed from sea-water both by clay minerals entering the oceans and by alteration of submarine igneous rocks. — Authors' abstract

Thompson, R. N. *See* Tilley, C. E. 02122

09374 **Thornton, Edward B.** A field investigation of sand transport in the surf zone, Chap. 22 *in* Coastal engineering, 11th Conf., London, 1968, Proc., V. 1: New York, Am. Soc. Civil Engineers, p. 335-351, illus., 1969.

The distribution of bed-load sand transport normal to the beach has been measured in a series of field experiments conducted in the surf zone at Fernandina Beach, Florida. Simultaneous measurements were made of the waves and water particle motion at various locations in the surf zone. The energy flux of the waves was resolved into its longshore component from the measured directional and energy spectra. It is found that the bed-load transport is related to the depth of water and longshore energy flux. Insight into the mechanics of sediment transport is obtained by comparing the wave and water particle motion energy spectra, which give a direct measure of the kinetic and potential energy, at various locations in the surf zone. — Author's abstract

Tiller, Kevin G. *See* Hodgson, J. F. 09381

02122 **Tilley, C. E.; Thompson, R. N.** Melting and recrystallization relations of the Snake River basalts of southern Idaho, USA: Earth and Planetary Sci. Letters, v. 8, no. 1, p. 79-92, illus., tables, 1970.

The experimental melting and recrystallization relations of some basalts of the Snake River Plain are investigated. They comprise two tholeiitic series, those of the Snake River and those of the King Hill and Craters of the Moon. The fractionation of the first group involves dominantly crystallization of olivine and plagioclase, with pyroxene fractionation playing a minor role, in accord with its very late crystallization in the experimental melting. In the second group removal of iron-titanium oxides and apatite accompanies olivine and plagioclase extraction and leads to silica enrichment, with corresponding reduction in rate of iron enrichment. Though a genetic link probably connects the two series its precise nature still remains to be disclosed. — Authors' abstract

Timko, Donald J. *See* Fertl, Walter H. 02209

Timko, Donald J. *See* Fertl, Walter H. 02210

09565 **Tiphane, Marcel.** Geology of the Magdalen Islands gypsum deposits [abs]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 217, 1969.

09507 **Todd, Ruth.** Recent literature on the Foraminifera: Cushman Found. Foram. Research Contr., v. 22, pt. 1, p. 38-43, 1969; ibid., pt. 2, p. 72-76, 1969; pt. 3, p. 110-118, 1969; pt. 4, p. 160-166, 1969.

01991 **Toksöz, M. Nafi; Wiggins, Ralph A.; Husebye, Eystein S.** Structure and properties of the Earth's core [abs.]: EOS, v. 51, no. 4, p. 359, 1970.

02030 **Tooker, E. W.; Morris, H. T.; Fillo, Paul V.** Mineral resources of the Emigrant Basin primitive area, California, *with a section on* Geophysical studies *by* H. W. Oliver: U.S. Geol. Survey Bull. 1261-G, p. G1-G70, illus., tables, geol. map, 1970.

Emigrant Basin primitive area consists of about 180 sq mi of lakes, streams, and mountains underlain by Mesozoic batholithic granitic rocks containing scattered remnants of deformed and metamorphosed Paleozoic rocks. Dikes and other intrusive bodies cut both granitic and metamorphic rocks; extrusive late Cenozoic volcanic rocks unconformably overlie granitic rocks in the north. Quaternary glaciation has exposed most bedrock leaving only sparse moraines; postglacial streams have deposited thin patches of alluvium. The mineral survey included geologic, geochemical, and geophysical surveying, and close study of known mineral deposits and of favorable areas. Only tungsten deposits occur in the area, but they are small, scattered, and discontinuous. No commercial mineral concentrations of ore minerals were found in hydrothermally altered zones; the overall mineral potential of the area is considered minimal. — *from* Author's abstract

02110 **Tógh, J.** A conceptual model of the groundwater regime and the hydrogeologic environment: Jour. Hydrology, v. 10, no. 2, p. 164-176, illus., 1970.

A conceptual model of hydrogeologic conditions is composed of two systems of physical and chemical parameters, the hydrogeologic environment and the groundwater regime. The three components of environment are: topography, geology, and climate; the six parameters of ground-water regime are: amount of water, geometric distribution of water movement, volume or velocity of flow, composition, temperature, and regime variance, or time changes of the above. Environment and regime are related quantitatively, and each regime parameter can be expressed as a function of the environmental components. This allows evaluation of the ground-water regime if environmental conditions are known, as well as inferences concerning the rock framework from known properties of the regime. Few parameters have been evaluated exactly, and mostly conceptual equations are presented. Conceptually the ground-water regime may be defined as the sum of the six environmental parameters. — *from* Author's abstract

09520 **Touray, J. C.** Hydrocarbures liquides et gazeux en inclusions dans les minéraux [with English abs.]: Centre Recherches Pau Bull., v. 3, no. 2, p. 429-441, illus., table, 1969.

After briefly describing hydrocarbon-bearing enclaves and inclusions in volcanic rocks and their minerals, the question of analysis of gaseous hydrocarbons (and more generally gases) in quartz veins is discussed with respect to a methodological point of view. One single analytical run may be without any geochemical significance. In contrast, multiple measures on the same sample, by use of mass spectrometry, help to localize included gases. In some cases it can be shown that there is only one "lacunary" site for CO_2 and CH_4; in others there are at least two distinct sites. Results are presented from optical, thermo-optical, and decrepitometric studies relative to petroleum-bearing inclusions in fluorite of Illinois and Tunisia, and light hydrocarbons bearing inclusions in authigenic quartz. The latter crystals are not rare; their fluid inclusions may be called "fossil indices." — *from* Author's English abstract

01875 **Tourtelot, Elizabeth B.** Selected annotated bibliography of minor-el[illegible] content of marine black shales and related sedimentary rocks: U.S. Geol. Su[illegible] 1293, 118 p., 1970.

Chemical data pertaining to the abundance and geochemical distribution of minor elements in marine black shale, related organic-rich fine-grained sedimentary rocks, and comparable modern marine sediments are summarized in this bibliography. About 375 abstracts from the world literature published from 1930 to 1965 are included. These are indexed by chemical element, geologic age, geographic distribution, and subject matter. Some of the black shales described represent ore deposits, whereas others contain unusually high concentrations of minor elements that may have potential future value as low-grade deposits. A few discussion papers on the source and distribution of minor elements are also included. — Author's abstract

02131 **Towe, K. M.; Malone, Philip G.** Precipitation of metastable carbonate phases from seawater: Nature, v. 226, no. 5243, p. 348-349, illus., tables, 1970.

This work describes preliminary experiments involving precipitation of metastable carbonates from sea water at room temperature, using ammonium carbonate generated by a vapor diffusion technique, or produced in place through the enzymatic decomposition of urea with urease. Because ammonium carbonate can be a natural by-product of biological activity, this suggests a mechanism by which such mineral phases might occur locally under marine conditions. The results suggest that the amount of ammonium carbonate added by diffusion or enzyme action and the pH of the sea water at the time determines the type of carbonate precipitated, and that particulate material may act as seeds and influence the final products. Additional work should indicate the degree to which these processes may operate in the local submarine environment where metastable carbonates of nonskeletal origin are observed. — DBV

09316 **Towse, Donald F.** Evaluation of cement raw materials [abs.]: Econ. Geology, v. 64, no. 8, p. 938, 1969.

02206 **Traugott, M. O.** Log evaluation of a heterogeneous carbonate reservoir, Cato San Andres field, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. E1-E8, illus., 1970.

Resistive shoulder-beds affect Laterolog-3 values, lithology variations affect porosity measurements, and moldic porosity causes the cementation exponent to vary from about 1.7 to 3.0 in the San Andres formation Cato field, New Mexico. New resistivity departure curves show that shoulder-bed effects cause the Laterolog-3 to record about 1.7 times too high in wet or tight intervals and to record nearly correct in permeable oil-bearing intervals. New interpretation techniques using Sonic log-Sidewall Neutron log overlays provide a quick and reliable method for determining lithology and cementation exponent. Use of these techniques results in more accurate saturation calculations and potential water-free completions. — Author's abstract

Travesi, A. *See* Morrison, G. H. 09622

Trollman, W. M. *See* Maher, J. C. 02114

Trueman, E. R. *See* Cox, L. R. 09443

Trümpy, R. *See* Grasmück, K. 09377

09378 **Trümpy, R.** Lower Triassic ammonites from Jameson Land (East Greenland), [Chap.] 2 *in* Notes on Triassic stratigraphy and paleontology of north-eastern Jameson Land (East Greenland): Medd. Grönland, v. 168, no. 2, p. 77-122, illus., tables, 1969.

Lower Eotriassic (Induan) ammonites from northern Jameson Land, especially Wegener Halvö are described. With the exception of few *Otoceras*, all belong to the Ophiceratids (*Glyptophiceras*, *Metophiceras*, *Ophiceras*, *Paravishnuites*, and "*Vishnuites*"); most can be referred to species described by Spath from Hold with Hope. A new subgenus to *Glyptophiceras*, *Hypophiceras*, is proposed for small forms from the very lowermost Triassic beds. Five new species are described and the zonal subdivision of the Eotriassic strata of East Greenland is discussed. — *from* Author's abstract

01992 **Tsai, Yi-Ben; Aki, Keiiti.** Surface wave amplitude spectra from explosions and earthquakes in southwestern United States [abs.]: EOS, v. 51, no. 4, p. 353, 1970.

09270 **Tschudy, R. H.** The plant kingdom and its palynological representation, [Chap.] 2 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 5-34, illus., tables, 1969.

Taxonomic classification systems of nonvascular and vascular plants are broadly outlined, and examples of representative spores and pollen are illustrated and dif-

ferentiated by morphological type (form, internal structures, surface sculpture) and, in higher plants, by homospory or heterospory. Palynomorph occurrences from Precambrian through Cenozoic are discussed; many fossil spores, especially of bryophytes and pteridophytes, are problematic in affinities and must be assigned to form genera. Most Eocene or younger pollen can be fitted into about 20 form categories based on position, type, and number of apertures. Cretaceous and early Tertiary pollen forms of the Normapolles group (Pflug, 1953) have complex, bizarre morphological features and cannot be placed in the usual categories; a key, definitions, and illustrations are provided here for interpretation of this difficult group. — VMJ

09337 **Tschudy, R. H.; Scott, R. A.** Introduction, [Chap.] 1 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 1-4, table, 1969.

Basis and historical development of the science of palynology (or, more precisely, paleopalynology when applied to fossil pollen and spores) are summarized. Palynological milestones in land plant evolution are enumerated: first trilete spores, Silurian; heterospory, Middle Devonian; monosulcate and bisaccate pollen, Pennsylvanian; and recognizable angiosperm pollen, late Early Cretaceous. — VMJ

09269 **Tschudy, Robert H.; Scott, Richard A.** (editors). Aspects of palynology: New York and London, Wiley-Interscience, 510 p., illus., tables, 1969.

This collaborative volume is an attempt to summarize the nature, scope, and applications of the study of fossil pollen and spores. Literature is reviewed and information is synthesized. Chapters 1-5 provide a general background: introduction, outline of plant kingdom and representative palynomorphs, wall structure and composition of palynomorphs, taxonomy and nomenclature, and relation to sedimentation. Chapters 6 and 7 deal with methods of interpreting the fossil record: causes of unreliability in palynological samples, and applications of palynology. In Chapters 8-17, the fossil plant record is summarized and palynological records from Precambrian through the early Cenozoic eras are treated. Chapter 18 treats dinoflagellates and other microfossils commonly found in palynological preparations. The chapters are cited separately. — VMJ

09273 **Tschudy, Robert H.** Relationship of palynomorphs to sedimentation, [Chap.] 5 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 79-96, illus., tables, 1969.

Adequate evaluation of fossil palynomorphs must take into account the sedimentation process and history of the host rock. Most palynomorphs were derived from land plants and were transported almost entirely by wind or water to the place of deposition, usually subaqueous, where they were deposited with the finer-grained clastics. The same factors influence deposition of palynomorphs and inorganic particles — particle size, shape, density, coagulability, and physical conditions at site. Concentration of pollen is affected by distance from shore and other factors. Palynomorphs are compressed by weight of overburden, but fine-grained matrices may protect them from distortion. During diagenesis, a reducing acidic environment is most favorable for preservation. Postdiagenetic alterations, including coalification, progressively obliterate palynomorph structure. — VMJ

09274 **Tschudy, Robert H.** Applied palynology, [Chap.] 7 *in* Aspects of palynology (R. H. Tschudy and R. A. Scott, editors): New York and London, Wiley-Interscience, p. 103-126, illus., table, 1969.

Applications of palynology are reviewed; principal applications are to stratigraphic correlation. Palynologic correlation was first used for peat and coal beds; later, notably in petroleum exploration, for shales and other lithotypes. The most serious correlation problems arise from nonrecognition of diastems or unconformities, or of faunal breaks. Palynological ages primarily must be verified by other age criteria such as established index fossils, or relation to strata of known relative age; the palynomorph assemblage can then be used as a basis for further dating, taking into ac-

count lithology and floral provincialism. Paleoecologic interpretations based on palynomorphs are usually valid for the late Cenozoic, but are subject to increasing limitations for successively older rocks. — VMJ

09260 **Tucker, John M.** Oak leaves of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 97-99, 1969.

Oak leaves are the most abundant specimens in the Rita Blanca fossil leaf flora. Fifty-nine fossil specimens were collected; these include *Quercus gambelii*, *Q. stellata*, and a number of specimens that cannot be referred to an extant form and are described here as a new species, *Q. ritablancensis*. The excellent state of preservation of a number of these fossil leaves suggests that they grew in the immediate vicinity of the lake. From this, and from their relative abundance in the fossil flora, it may be inferred that the oaks formed a dominant element in the lakeside vegetation. — *from* Author's introduction

09598 **Turner, Brian B.** Petrologic and structural relationships between anorthosite and adjacent rocks of the southern half of the Schroon Lake quadrangle, southeastern Adirondacks, New York [abs.], *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 305, 1968 [1969].

Turner, Ruth D. *See* Chavan, Andrè. 09497

02115 **Tuttle, Sherwood D.** Landforms and landscapes: Dubuque, Iowa, Wm. C. Brown Publishers, 136 p., illus., 1970.

This textbook of beginning geomorphology, aimed at the generalist rather than the specialist, illustrates various types of landforms and landscapes with portions of topographic maps, and describes the geologic agents which shape the Earth's surface such as running and ground water, glacial ice, wind and wind-driven waves, tectonic and volcanic forces, and also their actions such as weathering, erosion and deposition, mass wasting, volcanic and tectonic activity. One chapter covers the development of basic concepts in landform study from the geographical cycle theory to quantitative analysis and mathematical models. — EH

Tychsen, Paul C. *See* Dickas, Albert B. 09349

09268 **Ulmer, Gene C.** Experimental investigations of chromite spinels, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 114-131, illus., discussion, 1969.

Oxygen-fugacity buffering techniques have been applied to study the stability and extent of chromite spinel solid solutions. Data at subsolidus temperature of 1,300°C provide insight into phase relations among the six spinel end members: magnesioferrite, spinel, picrochromite, magnetite, hercynite, and chromite. While complete solid solution among these spinels does exist at 1,300°C, solid solutions may involve defect spinels that contain trivalent ions in excess of the 1:2 divalent to trivalent ratio. At one atm and 1,300°C, oxygen fugacities in the range 10^{-8} to 10^{-7} atm are necessary to form the range of compositions observed for natural spinels. A review of liquidus studies of effect of oxygen fugacity on fractional crystallization for several systems shows that both temperature and oxygen fugacity are important variables in petrogenesis of chromite-silicate sequences. — *from* Author's abstract

01873 **Urban, James B.** *Ancyrospora fallacia*, a new sporomorph exhibiting deceptive variations in preservation: Micropaleontology, v. 16, no. 2, p. 221-226, illus., 1970.

Fossil spores considered to be a new species of *Ancyrospora* have been recovered from the Cedar City Formation (Middle Devonian) of Callaway County, Missouri. It is possible to demonstrate numerous individual variations in morphology, due to the degree of completeness of preservation, that could conceivably result in different taxonomic assignments. The new species *Ancyrospora fallacia* is erected for these fossils. — Author's abstract

09457 **Urban, James B.** A study of the morphology of the spore genus *Ancyrospora* Richardson: Rev. Palaeobotany and Palynology, v. 9, nos. 1-2, p. 103-114, illus., 1969.

Scanning electron microscope studies show the outer exoexine to be lamellar and the inner exoexine to consist of a netlike or spongy layer. The inner exoexine forms a flange the optical characters of which are previously-observed wrinkles. Some are from the Devonian Cedar Valley Formation (Solon Member) of Iowa and others from the Calloway Formation of Missouri. Other details suggest that the genus can be emended and *A. simplex* can be redescribed. — HRC

U.S. Bureau of Reclamation. *See* U.S. Geological Survey. 09227

02039 **U.S. Geological Survey.** Aeromagnetic map of the Shutesbury quadrangle and part of the Millers Falls quadrangle, Franklin and Hampshire Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-697, scale 1:24,000, 1970.

02040 **U.S. Geological Survey.** Aeromagnetic map of the Boston North quadrangle, Middlesex, Suffolk and Essex Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-708, scale 1:24,000, 1970.

02041 **U.S. Geological Survey.** Aeromagnetic map of part of the Salem Depot quadrangle, Rockingham County, New Hampshire, and Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-712, scale 1:24,000, 1970.

02042 **U.S. Geological Survey.** Aeromagnetic map of part of the Newburyport West quadrangle, Essex County, Massachusetts, and Rockingham County, New Hampshire: U.S. Geol. Survey Geophys. Inv. Map GP-714, scale 1:24,000, 1970.

02043 **U.S. Geological Survey.** Aeromagnetic map of parts of the Gloucester and Rockport quadrangles, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-724, scale 1:24,000, 1970.

02044 **U.S. Geological Survey.** Aeromagnetic map of the Quabbin Reservoir quadrangle, Franklin, Worcester, and Hampshire Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-698, scale 1:24,000, 1970.

02045 **U.S. Geological Survey.** Aeromagnetic map of the Petersham quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-699, scale 1:24,000, 1970.

02046 **U.S. Geological Survey.** Aeromagnetic map of the Barre quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-700, scale 1:24,000, 1970.

02047 **U.S. Geological Survey.** Aeromagnetic map of the Wachusett Mountain quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-701, scale 1:24,000, 1970.

02048 **U.S. Geological Survey.** Aeromagnetic map of the Sterling quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-702, scale 1:24,000, 1970.

02049 **U.S. Geological Survey.** Aeromagnetic map of the Clinton quadrangle, Worcester County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-703, scale 1:24,000, 1970.

02050 **U.S. Geological Survey.** Aeromagnetic map of the Hudson quadrangle, Worcester and Middlesex Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-704, scale 1:24,000, 1970.

02051 **U.S. Geological Survey.** Aeromagnetic map of the Maynard quadrangle, Middlesex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-705, scale 1:24,000, 1970.

02052 **U.S. Geological Survey.** Aeromagnetic map of the Concord quadrangle, Middlesex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-706, scale 1:24,000, 1970.

02053 **U.S. Geological Survey.** Aeromagnetic map of the Lexington quadrangle, Middlesex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-707, scale 1:24,000, 1970.

02054 **U.S. Geological Survey.** Aeromagnetic map of part of the Marblehead South quadrangle, Essex and Suffolk Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-710, scale 1:24,000, 1970.

02055 **U.S. Geological Survey.** Aeromagnetic map of part of the Haverhill quadrangle, Essex County, Massachusetts, and Rockingham County, New Hampshire: U.S. Geol. Survey Geophys. Inv. Map GP-713, scale 1:24,000, 1970.

02056 **U.S. Geological Survey.** Aeromagnetic map of part of the Newburyport East quadrangle, Essex County, Massachusetts, and Rockingham County, New Hampshire: U.S. Geol. Survey Geophys. Inv. Map GP-715, scale 1:24,000, 1970.

02057 **U.S. Geological Survey.** Aeromagnetic map of the Lawrence quadrangle, Essex and Middlesex Counties, Massachusetts, and Rockingham and Hillsborough Counties, New Hampshire: U.S. Geol. Survey Geophys. Inv. Map GP-716, scale 1:24,000, 1970.

02058 **U.S. Geological Survey.** Aeromagnetic map of the South Groveland quadrangle, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-717, scale 1:24,000, 1970.

02059 **U.S. Geological Survey.** Aeromagnetic map of the Georgetown quadrangle, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-718, scale 1:24,000, 1970.

02060 **U.S. Geological Survey.** Aeromagnetic map of part of the Ipswich quadrangle, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-719, scale 1:24,000, 1970.

02061 **U.S. Geological Survey.** Aeromagnetic map of the Wilmington quadrangle, Middlesex and Essex Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-720, scale 1:24,000, 1970.

02062 **U.S. Geological Survey.** Aeromagnetic map of the Reading quadrangle, Middlesex and Essex Counties, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-721, scale 1:24,000, 1970.

02063 **U.S. Geological Survey.** Aeromagnetic map of the Salem quadrangle, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-722, scale 1:24,000, 1970.

02064 **U.S. Geological Survey.** Aeromagnetic map of part of the Marblehead North quadrangle, Essex County, Massachusetts: U.S. Geol. Survey Geophys. Inv. Map GP-723, scale 1:24,000, 1970.

09227 **U.S. Geological Survey; Arizona Bureau of Mines; U.S. Bureau of Reclamation.** Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), 638 p., illus., tables, geol. map, 1969.

This report, summarizing the mineral and water resources of Arizona, presents factual information on present supplies of minerals and water in the State and a realistic appraisal of supplies available for future exploitation. Part I, geology and mineral resources, describes the mineral industry of Arizona and relates it to other parts of Arizona's economy. Part II, water resources, describes the physical environment and water provinces of the State, followed by descriptions of the water resources under

each respective water province. In Part III, water resources development, present and potential water resource developments, water conservation practices, and various research programs are discussed. — WLG

Ushakov, S. A. *See* Gaynanov, A. G. 09154

09435 **Uthe, Richard E.** Geochemical considerations of Clinton iron ore deposition: Compass, v. 46, no. 3, p. 169-180, illus., 1969.

Formation of the iron ore by precipitation of hematite in a shallow oceanic collecting area saturated in calcium carbonate is considered. The iron is believed to have been carried in the form of iron(II) ions traveling in moderately acidic rivers draining a mafic source area; upon reaching the higher Eh-pH environment of the ocean, iron was precipitated as iron(III) oxide. An Eh-pH diagram for hematite-magnetite-siderite is developed, and limiting values of iron concentration in modern streams and those that could have been in the Clinton paleoriver are plotted on it. Calculations show that the iron content of modern streams is much more than could exist at equilibrium with hematite. It is concluded that the species and reactions now considered most important during sedimentary iron deposition do not appear to be valid. — *from* Author's abstract

02086 **Valentine, James W.** How many marine invertebrate fossil species, a new approximation: Jour. Paleontology, v. 44, no. 3, p. 410-415, illus., tables, 1970.

Marine species diversity today appears to be more than an order of magnitude greater than the mean standing species diversity during the Paleozoic. The major cause of the inferred rise of species diversity to the present level is the provincialization of the marine biosphere due to continental drift and to increased latitudinal temperature gradients. Using inferred levels of species diversity throughout the Phanerozoic, the total numbers of marine invertebrate species that are represented by recognizable remains can be estimated as between 342,000 and 1,543,000, a range that is significantly lower than previously suggested. — Author's abstract

09187 **VanAlstine, R. E.; Moore, R. T.** Fluorspar, *in* Mineral and water resources of Arizona: U.S. Cong., 90th, 2d sess., Senate Comm. Interior and Insular Affairs Comm. Print (Arizona Bur. Mines Bull. 180), p. 348-357, illus., table, 1969.

Nearly half of the fluorspar deposits for which geologic information is available are in coarse-grained intrusive rocks of various ages; host rocks at the other deposits are about equally divided between sedimentary, volcanic, and metamorphic rocks. Fifty-six of the known deposits, locality, manner of occurrence, and references are tabulated. At nine of the localities the deposits consist predominantly of fluorite; quartz and calcite are the chief gangue minerals. Galena or barite have been of commercial interest at 14 localities. An investigation of 75 barite deposits showed that about half contain fluorite and range from less than 1 to 48.6 percent CaF_2. Many of the other fluorspar localities are deposits that have been worked at some time for copper, manganese, tungsten, or gold. At six of the localities the fluorspar is associated with uranium minerals. — WLG

09390 **vanderBeck, Roland R.** Refractory properties of a Florida kyanite-sillimanite concentrate: Am. Ceramic Soc. Bull., v. 48, no. 7, p. 703-706, illus., tables, 1969.

A kyanite-sillimanite concentrate from Florida beach sand was equal in pyrometric cone equivalent to quarried kyanite. For 100 mesh materials, expansion on heating due to mullitization was approximately half that of raw kyanite. Ceramic bodies made from the kyanite-sillimanite concentrate were somewhat stronger than those containing kyanite when processed under identical conditions. Specimens of the concentrate had higher powder bulk density, higher fired density and greater fired strength than specimens of the quarried kyanite. — Author's abstract

vanDonk, Jan. *See* Broecker, Wallace S. 02142

VanNoy, Ronald M. *See* Becraft, George E. 01878

09493 **Van Valen, Leigh.** What was the largest dinosaur?: Copeia 1969, no. 3, p. 624-626, table, 1969.

This note discusses probable sizes of the late Jurassic sauropod *Brachiosaurus brancai*, usually regarded as the largest known dinosaur, and *Antarctosaurus*, a titanosaurid sauropod of Late Cretaceous age originally described by Huene (1929) from Patagonia, and now also known from Uruguay, India, and probably Kasakhstan. — MCM

02152 **Verille, G. J.; Sanderson, G. A.; Rea, B. D.** Missourian fusulinids from the Tensleep Sandstone, Bighorn Mountains, Wyoming: Jour. Paleontology, v. 44, no. 3, p. 478-479, illus., 1970.

Missourian fusulinids [*Triticites* sp.] collected from the Tensleep Sandstone at Dry Kelly Creek, Johnson County, Wyoming, are illustrated and compared with fusulinids of similar age from other parts of Wyoming. These fusulinids provide a valuable point of control for determining the distribution of Upper Pennsylvanian rocks in north-central Wyoming. — Authors' abstract

Vincenz, S. A. *See* Guja, N. H. 01917

09408 **Virgo, David; Hafner, Stefan S.** Fe^{2+},Mg order-disorder in heated orthopyroxenes, *in* Pyroxenes and amphiboles — Crystal chemistry and phase petrology: Mineralog. Soc. America Spec. Paper 2, p. 67-81, illus., tables, 1969.

The Fe^{2}, Mg distribution over the octahedrally coordinated sites M1 and M2 in orthopyroxenes was investigated by Mössbauer spectroscopy at different temperatures and pressures. The distribution equilibrium constant was determined for 1000°C, and approximately determined for 800, 700, 600, and 500°C. For kinematic experiments with an orthopyroxene $x = 0.574$, the rate constants for disordering at 500 and 1000°C were estimated. The average activation energy for disordering is about 20 kcal per mole and that for ordering about 15-16 kcal per mole. It is concluded that the Fe^{2}, Mg exchange between the octahedral sites in orthopyroxenes is a rapid process. Those in metamorphic rocks are expected to have equilibrated distributions, whereas those in rapidly cooled volcanic rocks may have metastable distributions. — *from* Authors' abstract

Vita, O. A. *See* Walker, C. R. 02219

02133 **Vogt, P. R.** Magnetized basement outcrops on the south-east Greenland continental shelf: Nature, v. 226, no. 5247, p. 743-744, illus., 1970.

Vogt and Ostenso (1969) suggested that the initial margins of the continents, at first warped upwards, are in time reduced to sea level by erosion and thermal contraction. The East African rift represents the first two of eight depicted stages; the Red Sea the third; and so far most margins of the Atlantic resemble the last three stages. A bathymetric-magnetic traverse across the southeast Greenland shelf seems to reveal the fourth or fifth stage, regions of rough, short-wavelength topography and magnetic anomalies where the basement is probably exposed; its eroded surface has been lowered to sea level but is not yet buried by sediments younger than the rift that separated Scandinavia and the British Isles from Greenland. The oldest ocean floor between Greenland and Rockall-Hatton Bank has been dated at 60 m.y. B.P. — DBV

Vogt, Peter R. *See* Johnson, G. Leonard. 01934

01993 **Vogt, Peter R.; Lorentzen, G. R.; Dennis, L. S.** An aeromagnetic survey of the KEATHLEY magnetic anomaly sequence between 34° N and 40° N in the western North Atlantic [abs.]: EOS, v. 51, no. 4, p. 274, 1970.

09608 **Vogt, Peter R.; Avery, Otis E.; Schneider, Eric D.; Anderson, Charles N.; Bracey, Dewey R.** Discontinuities in sea-floor spreading, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 285-317, illus., 1969.

Various criteria are examined by which time variations in the rate and direction of sea-floor spreading, which have occurred simultaneously along much of the Mid-Oceanic Ridge at 10-30 m.y. intervals, might be recognized. The recent discovery that transform faults may be created and destroyed repeatedly during the life of an ocean basin suggests several physical models for creation and destruction of such faults. The shape of the Mid-Oceanic Ridge may represent a minimum-work configuration for a particular spreading rate and direction. When these quantities change the ridge shape adjusts itself to a new configuration if the energy barrier is not too great. Rotation of a ridge segment with respect to spreading direction may require several million years and depends on spreading rate, ridge orientation, and fracture spacing. Observed rotation rates are about one-third or one-half the theoretical maximum. — *from* Authors' abstract

vonEngelhardt, W. *See* Dence, M. R. 01902

01994 **VonHerzen, Richard P.; Anderson, Roger N.** Heat-flow variability in the eastern equatorial Pacific [abs.]: EOS, v. 51, no. 4, p. 317, 1970.

vonHuene, Roland. *See* Holmes, Mark L. 01925

09317 **Wagner, Richard J.** Geology and zonation of the southeast Missouri barite district [abs.]: Econ. Geology, v. 64, no. 8, p. 938-939, 1969.

02034 **Wahrhaftig, Clyde.** Geologic maps of the Healy D-2, D-3, D-4, and D-5 quadrangles, Alaska: U.S. Geol. Survey Geol. Quad. Maps GQ-804-807, scale 1:63, 360, sections, 1970.

02085 **Wahrhaftig, Clyde.** Geologic map(s) of the Fairbanks A-2, A-3, A-4, and A-5 quadrangles, Alaska: U.S. Geol. Survey Geol. Quad. Maps GQ-808-811, scale 1:63,360, sections, 1970.

09306 **Walker, Alan L.; Buchanan, A. S.** Geochemical processes in ore formation — Pt. 1, The production of hydrothermal fluids from sedimentary sequences: Econ. Geology, v. 64, no. 8, p. 919-922, illus., tables, 1969.

The effect of heating a number of rock samples at low pressures has been investigated. It has been found that at temperatures as low as 300°-400°C, a highly reactive complex gaseous mixture is evolved, the components of which have been identified by using a mass spectrometer. The gaseous mixture is likely to be important in mineral transport and recrystallization processes in near-surface fumarolic conditions. — Authors' abstract

09364 **Walker, Alan L.; Buchanan, A. S.** Geochemical processes in ore formation — Pt. 2, Kinetics of high-temperature gas-phase metal transport and the relation of the model systems to the natural environment: Econ. Geology, v. 64, no. 8, p. 923-931, illus., table, 1969.

HCl was used as the gas in experimental study of vapor-phase transport of metals. The rates at which HCl reacted with galena, sphalerite, and chalcocite were investigated at relatively low pressure (30-70 cm Hg) and temperatures in the vicinity of 500°-600°C. The rates of attack decrease in the order PbS, ZnS, Cu_2S. The paragenesis and zoning of mineral deposits formed by mobilization or remobilization are determined by these reaction rates, by the nature of the transporting channel (relative importance of diffusion vs. movement of fluid), and the kinetics of the depositing reaction. — WSW

02219 **Walker, C. R.; Vita, O. A.** The precise determination of uranium in impure uranyl nitrate and uranium oxides [with French and German abs.]: Anal. Chim. Acta, v. 49, no. 3, p. 391-400, illus., tables, 1970.

A simple method for direct determination of uranium in compounds containing up to several percent impurities with a precision of 0.04 percent at the 95 percent confidence interval is presented. A sample containing about 2.5 g of uranium is dissolved

in strong phosphoric acid and uranium(VI) is reduced with iron(II). After selective oxidation of the excess iron(II) with nitrate in presence of molybdate catalyst, a small excess of potassium dichromate is added to oxidize uranium(IV) to uranium(VI). The excess of chromium(VI) is determined colorimetrically with diphenyl-carbazide. The method requires some prior knowledge of the uranium content of the sample. It can be applied even in the presence of percent levels of impurities such as iron, nickel, and chromium. Copper, however, at concentrations of more than 1 percent of the uranium, causes a low bias. — *from* Authors' summary

Wall, R. E. *See* Taylor, P. T. 01987

Wallace, Sandra. *See* Hills, L. V. 02160

01995 **Walsh, Joseph B.** Correcting dK/dp for porosity [abs.]: EOS, v. 51, no. 4, p. 419, 1970.

Walter, L. S. *See* Dence, M. R. 01902

02106 **Walton, William C.** Groundwater resource evaluation: New York, McGraw-Hill Book Co., 664 p., illus., tables, 1970.

This college textbook, designed for teaching ground-water courses to engineers and geologists, presents both basic principles of ground-water resource evaluation and practical application of techniques to well and aquifer problems. Derivation of equations as well as numerous illustrative case histories of analyses based on actual field data are presented; numerical practical problems may be solved with available equations and methods of analysis. Chapter headings are: introduction; ground-water movement, storage, exploration, and data; basic principles and fundamental equations; aquifer test and flow-net analysis; well-design criteria, construction, production tests, and maintenance; ground-water recharge and runoff; quality of ground water; hydrogeologic systems analysis; and development and management of aquifers. References are given at the end of each chapter; a subject index is appended. — MCM

01996 **Wang, Chi-yuen.** The upper mantle beneath tectonic regions [abs.]: EOS, v. 51, no. 4, p. 358, 1970.

09472 **Ward, S. H.** Geophysical problems — Coppermine area [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 211, 1969.

Wasserburg, G. J. *See* Eugster, O. 02137

09461 **Wasserburg, G. J.; Papanastassiou, D. A.; Nenow, E. V.; Bauman, C. A.** A programmable magnetic field mass spectrometer with on-line data processing: Rev. Sci. Instruments, v. 40, no. 2, p. 288-295, illus., tables, 1969.

A single focusing magnet mass spectrometer was constructed with symmetric conjugate foci calculated from fringe field data and corresponding to a beam deflection of 68°. Experimental and calculated optical characteristics agree well. A rotating coil probe and a rate coil are employed as field sensors for a nulling device and for field scanning. The magnetic field can be set to 27 values corresponding to the center of spectral and zero lines on both sides of each peak. The automatic scanning consists of: rapid field change between adjacent field values; locking in at the present field values; and remaining in a channel for a preset time during which the ion beam current is integrated and data digitized. Data consist of channel intensity, scale factors, and internally provided clock time; data signals drive a typewriter and tape punch. A cyclic scan of five isotopes including background requires 35 sec. — *from* Authors' abstract

Wasson, John T. *See* Baedecker, Philip A. 01901

09345 **Wasylikowa, Krystyna.** Historia roślinności Ameryki Północnej w późnym czwartorzedzie na podstawie badań palynologicznych [The history of late Quaternary

vegetation in North America on the basis of pollen analysis (with English and Russian summ.)]: Folia Quaternaria, no. 32, 74 p., illus., tables, 1969.

Present knowledge of changes in climate and vegetation of the United States and Canada from the Wisconsin glaciation to the time of European settlement is reviewed. Results of palynological investigation are discussed separately for the Great Lakes region, New England, unglaciated southeastern States, southwestern States, Pacific Northwest, Alaska, and Canada. Five time-stratigraphic units (in years B.P.) are adopted: full-glacial, 22,000-15,000; late-glacial, 15,000-10,500; early postglacial, 10,500-8000; middle or hypsithermal, 8,000-4,000; and late postglacial, 4,000 to present. Pollen diagrams reflect plant distributions, clues to regional changes in temperature and humidity with glacial advances and retreat. Problems for further investigation concern tundras, plant migration where no mountain barriers exist, survival of "thermophilous" trees, and synchronous movements of regional ice lobes. — GDC

01997 **Watkins, N. D.; Cambray, W.; Richardson, A.** Paleomagnetism of Cretaceous dikes from Jamaica [abs.]: EOS, v. 51, no. 4, p. 270, 1970.

09535 **Watkins, N. D.** Crustal spreading, a critical comparison of hypothesis reuirements and present knowledge of relevant magnetic properties and polarity history [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Si. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 544, 1969.

09386 **Wayhan, D. A.; McCaleb, J. A.** Elk Basin Madison heterogeneity, its influence on performance: Jour. Petroleum Technology, v. 21 [no. 2], p. 153-159, illus., table, 1969.

The Elk Basin anticline, Wyoming-Montana border, is one of the giant fields originally having more than a billion barrels of oil. Tensleep Sandstone, Pennsylvanian, and Madison Limestone, Mississippian, are the most important reservoirs. When production declined, a review of logs and cores indicated complex zonation in the Madison section. A study was undertaken, and an ABCD zonation concept was developed. Four distinct rock units were described. Gathering additional reservoir data involved cutting and analyzing over 3,000 feet of core; the original Madison heterogeneity has been altered by erosion, solution, and collapse. The new subzones are discussed in connection with production. A major thrust fault on the east side of the anticline is a barrier to fluid influx. Additional wells have been drilled and production has increased. — ESL

09318 **Wayland, Thomas E.** Geologic occurrence and evaluation of bentonite deposits [abs.]: Econ. Geology, v. 64, no. 8, p. 939, 1969.

09392 **Weaver, D. W.** General geology of the region, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 9-10, illus., 1969.

The Northern Channel Islands are geographically and geologically alined with the east-west trending Santa Monica Mountains in southern California. The island chain appears to be a faulted, east-west trending anticline with both flanks represented in outcrops on Santa Cruz and Santa Rosa, but with only the northern flank exposed on San Miguel. Upper Cretaceous through mid-Miocene rocks total 23,000 feet, and include about 8,000 feet of volcanics; all rest upon a pre-Cretaceous metamorphic basement. Pleistocene deposits, largely sands, occur also over all of the islands. — HRC

09393 **Weaver, D. W.** The Cretaceous rocks, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 14-16, illus., table, 1969.

Cretaceous rocks crop out only on San Miguel Island, are in the subsurface in the Santa Barbara channel three miles away, and are in the subsurface of Santa Cruz Island. On San Miguel Island, the rocks consist of 6,325 feet of sandstone and shale, and the base is not exposed; the sequence is comparable to Jalama Formation of the Santa Ynez Mts. Foraminifera are abundant and permit detailed age determinations for the various parts. The San Miguel Jalama is much thicker than the Santa Ynez Jalama, and the two sequences, on opposite sides of the present day embayment, represent part of a continuous basin of deposition during Cretaceous, with a warm, shallow, near shore environment. A list of Foraminifera is included. — HRC

09395 **Weaver, D. W.; Doerner, D. P.** Lower Tertiary stratigraphy, San Miguel and Santa Rosa Islands, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 30-47, illus., tables, 1969.

The lowermost units as exposed at Simonton Cove, San Miguel Island, are the undifferentiated Pozo-Cañada Formation, 2247 feet thick, and largely sandstone and shale. Overlying this and also exposed on Santa Rosa is the middle and late Eocene South Point Formation which is 700 feet thick; over this is the Cozy Dell Formation, 364 feet thick. At the top of the section is the Sespe Formation, at least 480 feet thick, which is probably not as old as late Eocene. Faunal lists, primarily foraminiferans, are included. — HRC

Weaver, D. W. *See* Avila, F. A. 09396

09397 **Weaver, D. W.; Doerner, D. P.** Mid-Tertiary stratigraphy, San Miguel Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 80-84, illus., table, 1969.

A sequence of fine- to coarse-grained clastics and volcanics over 3,500 feet thick, exposed along the southeast shore of San Miguel Island, rest with angular discordance of 5° or more upon the upper Eocene Narizian sandstones and shales of Crook Point; consist of the Rincon, San Miguel, and Monterey Formations; and range in age from upper Oligocene Zemorrian to middle Miocene Luisian. The upper limit of the sequence is terminated by an unconformity with the Pleistocene and Holocene terrace and beach-sand deposits. Faunal lists are included. — HRC

09398 **Weaver, D. W.; Griggs, G.; McClure, D. V.; McKey, J. R.** Volcaniclastic sequence, south central Santa Cruz Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 85-90, illus., 1969.

The San Onofre Breccia, composed of schist-fragments, sandstone, and conglomerates, rests conformably on the Saucesian Rincon Formation and is 1,500 feet thick; sediments were deposited in a shallow marine basin. The overlying Blanca Formation (new) is massive to thick-bedded, light colored, epiclastic volcanic rocks of lower and possibly middle Miocene age; it is at least 1432 feet thick, and the top of the formation is eroded. Three members can be recognized: a thin to thick bedded rhyolite or dacite cobble conglomerate with pebbly lithic tuffaceous sandstone interbeds at the base; the middle member, a 300-400 feet thick unit of massive tuff-breccia interbedded with tuffaceous sandstone and conglomerate; and the upper member, a resistant, thick-bedded volcanic conglomerate or breccia. — HRC

09400 **Weaver, D. W.; Meyer, G. L.** Stratigraphy of northeastern Santa Cruz Island, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 95-104, illus., table, 1969.

The oldest exposed rocks are the andesites and dacite flows, breccias, sandstones, and tuffs that make up the Devils Peak and Prisoners Harbor Members of the Santa Cruz Island Volcanics; these are not much younger than late Saucesian (Miocene). The total thickness (including some in the subsurface) is about 3,500 feet. The series is overlain by the Monterey Formation, shale and chert, of Miocene age and at least 1,570 feet thick. The Potato Harbor Formation lies unconformably upon the Monterey, is commonly less than 20 feet thick, and is a late Pliocene or early Pleistocene soft, sandy limestone. The overlying Middle Anchorage Alluvium is the youngest material on the island. Faunal lists are included. — HRC

09504 **Weaver, D. W.** Paleogeographic implications and geologic history, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 115-124, illus., 1969.

The Northern Channel Islands are developed along the Malibu-Santa Rosa Fault system. The Cretaceous and Tertiary rocks rest unconformably upon Jurassic and older basement rocks. Late Cretaceous rocks, over 6,300 feet thick, are outer shelf or slope deposits. A period of emergence may have followed (the evidence is contradictory) after the Cretaceous; progressive subsidence occurred during the Paleocene and Eocene; deformation followed, after which time Oligocene rocks were deposited. Following early Miocene deformation, clastic rocks and volcanics were deposited. No late Miocene or early Pliocene rocks are present, but late Miocene orogeny is recognized from possibly late Pliocene or early Pleistocene sediments unconformable upon all earlier rocks. — HRC

09624 **Weaver, D. W.** The pre-Tertiary rocks, *in* Geology of the Northern Channel Islands, southern California borderland (by D. W. Weaver and others): [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Sec., p. 11-13, 1969.

Basement rocks form an elongate core in the central part of Santa Cruz Island and are in fault contact with the Tertiary rocks. The oldest of these is the Santa Cruz Island Schist. The Alamos Tonalite intrudes the schist and has subsequently been metamorphosed. Another larger body, the Willows Diorite, is in fault contact everywhere with the schist. Petrographic examinations indicate that the schist was derived from basic igneous rocks, probably flows. No fossils are known in the schist, but it is probably pre-Late Jurassic, since the K-Ar age of the Willows Diorite is 145 ± 5 m.y. — HRC

09625 **Weaver, Donald W.; Doerner, David P.; Nolf, Bruce.** (and others). Geology of the Northern Channel Islands, southern California borderland: [Los Angeles, Calif.] Am. Assoc. Petroleum Geologists and Soc. Econ. Paleontologists and Mineralogists, Pacific Secs., 200 p., illus., tables, geol. maps, 1969.

A complete geologic description of the three islands in the Santa Barbara channel are given. A few areas of pre-Cretaceous basement metamorphic rocks are present, although almost all of the islands are underlain by Cretaceous and Tertiary rocks. Volcanic rocks are also included in the Tertiary. Results of a gravity survey reflect the highly complex structures. Tertiary foraminifera are illustrated. Oil seeps on and near the islands are common, and led much of the petroleum activity in the region in the past. — HRC

Webber, G. R. *See* Azzaria, L. M. 09477

Weber, J. R. *See* Sobczak, L. W. 02179

09266 **Weber, Jon N.** Carbon and oxygen isotopic composition of carbonate material in the Rita Blanca varves, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 47-58, illus., tables, 1969.

There is a consistent enrichment of C-12 and O-16 in the dark layers of the Rita Blanca varves. Because of difference in isotopic compositions between seasonal varve

layers, individual analyses were grouped to obtain δ values for 40-, 60-, 80-, and 100-year intervals. The major factor controlling the C-12:C-13 ratio of carbonate sediments is organic activity which would be influenced by climate. Dry periods with increased evaporation of lake and stream water, would tend to concentrate O-18 in the water and hence lead to O-18 enrichment of the carbonate formed in the lake. Wet periods with increased rainfall would result in larger quantities of stream water, enriched in O-16 relative to lake water, reaching the lake. Except for the first few hundred years, the pattern shown by carbon isotope ratios is almost identical with that of the oxygen isotope ratios. The most probable cause of the "cyclic", variation is climatic fluctuations. — HRC

02103 **Weertman, J.** The creep strength of the Earth's mantle: Rev. Geophysics and Space Physics, v. 8, no. 1, p. 145-168, illus., tables, 1970.

It is probable that at stresses greater than about 10^{-2} bar creep in the Earth's mantle is caused by dislocation motion rather than by mass transport of atoms through diffusion from one grain boundary to another; the latter process leads to Nabarro-Herring creep, which should be dominant only at very low stresses (100^{-2} bar). Dislocation creep equations are used to estimate 'effective viscosity' at a constant creep rate of 10^{-16} Sec^{-1} of the Moon, Mars, and mantles of Venus and Earth. Effective viscosity of mantles of Venus and Earth diminishes with increasing depth, goes through a minimum, and then increases continously up to the mantle-core boundary. Effective viscosity in the lower mantle is much smaller than estimates derived from the Nabarro-Herring creep equation. — *from* Author's abstract

01998 **Weetman, Bruce G.; Davis, L. L.; Foote, R. Q.; Hays, W. W.** Seismic anomaly at NRDS, Nevada [abs.]: EOS, v. 51, no. 4, p. 359, 1970.

Weir, John. *See* Newell, N. D. 09447

Weir, John. *See* LaRocque, Aurèle. 09448

02036 **Weld, Betsy A.; Griffin, Margaret S.; Brett, George W.** Reports and maps of the Geological Survey released only in the open files, 1969: U.S. Geol. Survey Circ. 618, 23 p., 1970.

This circular contains a list of maps and reports released by the U.S. Geological Survey during 1969 that are available for public inspection in the open files; copies of the reports and maps may be made upon request at the requestor's expense. The reports are arranged alphabetically by author; each is preceded by a serial number used to identify it in the index. — MCM

09153 **Welles, S. P.; Estes, Richard.** *Hadrokkosaurus bradyi* from the upper Moenkopi Formation of Arizona, with a review of the brachyopid labyrinthodonts: California Univ. Pubs. Geol. Sci., v. 84, 61 p., illus., tables, 1969.

An amphibian skull from the upper part of the Moenkopi Formation of northern Arizona is referred to *Hadrokkosaurus bradyi* of the labyrinthodont family Brachyopidae. *Hadrokkosaurus* is the largest and most advanced of the known brachyopids, and this discovery supports an early Middle Triassic age for the upper Moenkopi. Stratigraphic range of the Brachyopidae is Late Permian to Middle Triassic. Important characteristics defining the family are described; 10 genera are excluded because they lack these characters or are indeterminate. *Batrachosuchoides* is questionably synonymized with *Batrachosuchus*, and "*Platyceps*" *wilkinsoni* is tentatively included in *Bothriceps*. — *from* Authors' abstract

09302 **Wells, John W.** The formation of dissepiments in zoantharian corals, *in* Stratigraphy and palaeontology — Essays in honour of Dorothy Hill (K. S. W. Campbell, editor): Canberra, Australian Natl. Univ. Press, p. 17-26, illus., 1969.

Dissepiments of zoantharian corals have been generally supposed to be the result of discontinuous tractive updrawals of the polyp followed by deposition of a sheet of skeletal material sealing off the voids. The pseudoperculae of some Paleozoic and

similar structures in Recent scleractinians show, however, that secretion of dissepimental tissue is not simultaneous over an updrawn secreting surface but by incremental centripetal deposition of a very thin layer that is later thickened. That traction creates the voids also seems doubtful; it is more probable that they develop by hydraulic lifting of the secreting surface as a result of the accumulation of fluid ('blistering') between dissepiment and the pedal disc of the polyp ('Wedekind's theory'). — Author's summary

09214 **Werner, Floyd G.** Terrestrial insects of the Rita Blanca Lake deposits, *in* Paleoecology of an early Pleistocene lake on the High Plains of Texas: Geol. Soc. America Mem. 113, p. 123-130, 1969.

Terrestrial insects, except for weevils, from the lake deposits are described and illustrated. They are only of moderate value in helping clarify the climatic or ecologic setting of the lake as the identification to group are too general to be of value, and most of the species that could be identified with certainty are widespread. Those in great abundance were probably associated with the lake, whereas some individuals may have entered by accident. The three meloid beetles might indicate that the surrounding country was mostly grassland. There is a conspicuous absence of wood-boring insects; one might expect a few of the adults if they were abundant. — *from* Author's introduction

01999 **Wesson, Robert L.; Kovach, Robert L.** Laterally inhomogeneous velocity models along the San Andreas fault [abs.]: EOS, v. 51, no. 4, p. 361, 1970.

09550 **Whalen, Charles T.** Summary of 1st Geodetic Survey Squadron gravity activities in western United States 1963-1968, *in* Symposium on gravity surveys in western North America (David F. Barnes, editor): EOS, v. 50, no. 10, p. 529, 1969.

The U.S. Air Force First Geodetic Survey Squadron shares responsibility for completion of the regional gravity surveys in the U.S. with the Army Topographic Command. The squadron has been assigned responsibility for completing regional gravity surveys in Arkansas, Colorado, Florida, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming. Since 1963, the Gravity Division has observed the following anomaly stations in the western U.S.: Colorado, 1,038; Idaho, 199; Montana, 848; Nevada, 608; New Mexico, 1,210; Utah, 703; and Wyoming, 592. — GV

09589 **Wheeler, E. P., 2d.** Minor intrusives associated with the Nain anorthosite, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 189-206, illus., tables, 1968 [1969].

Adamellite is the principal rock of a small intrusive near Nain, Labrador. The mafic mineral content is generally low, the most common phase being high-iron olivine. Zoned clinopyroxene occurs near the chilled margins. Where contacts are well defined, the marginal rock may be mangerite. Some anorthosite contacts are transitional, being marked by diorites intermediate between anorthosite and adamellite. This body is one of many minor intrusives that accompany the major bodies of the unmetamorphosed Nain anorthosite-adamellite complex and which in conjunction with them forms a comagmatic group near the boundary between the Elsonian and Kenoran orogenic provinces. The trend in differentiation was toward strong iron concentration in the later stages. — *from* Author's abstract

White, E. W. *See* Baun, W. L. 09294

White, Natalie D. *See* Ligner, J. J. 09265

White, W. A. *See* Gross, D. L. 02118

White, W. Arthur. *See* Shimp, Neil F. 02204

White, William B. *See* Rauch, Henry W. 01970

Whitehead, N. E. *See* Brooks, R. R. 09426

Whitney, Philip R. *See* Reynolds, Robert C., Jr. 09595

Wichmann, P. A. *See* Youmans, A. H. 02214

Wier, K. L. *See* James, H. L. 09335

Wier, K. L. *See* Pettijohn, F. J. 09343

Wiggins, Ralph A. *See* Toksöz, M. Nafi. 01991

Wilkins, A. L. *See* Jongejan, A. 02111

02000 **Wilkniss, Peter E.; Carr, Roderick A.; Hoover, John I.** Submarine volcanism and chemical changes in seawater [abs.]: EOS, v. 51, no. 4, p. 328, 1970.

09517 **Willden, Ronald; Kistler, R. W.** Geologic map of the Jiggs quadrangle, Elko County, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ-859, scale 1:62,500, section, 1969.

02082 **Williams, Garnett P.** Flume width and water depth effects in sediment-transport experiments: U.S. Geol. Survey Prof. Paper 562-H, p. H1-H37, illus., tables, 1970.

Results of 177 flume experiments made in channels of different widths and water depths are given. Narrower flume widths affected some variables, but in a channel two feet wide, flume sidewall effects disappeared. Channel width did not affect unit water discharge-unit sediment transport relations at constant water depth. The slope decreased as the channel became wider for a given unit transport rate and water depth. By measuring change in dependent variables with channel width, an empirical adjustment equation was obtained to correct the slope, stream power, and shear stress for sidewall effect. Adjustment factors are also given for correcting unit sediment-transport rate for sidewall effects; this rate increased fourfold to sixfold as water depth decreased. Flume width influenced bed-form characteristics; heights and travel rates can be quite different in wide and narrow channels. — *from* Author's abstract

Williams, Paul G. L. *See* Bancroft, G. Michael. 09407

02001 **Williams, Spencer L.; Davis, L. L.; Foote, R. Q.; Hays, W. W.** Seismic response at Tonopah, Nevada, to underground nuclear explosions [abs.]: EOS, v. 51, no. 4, p. 345, 1970.

09218 **Wilson, H. D. B.; Bateman, Alan M.** (editors). Magmatic ore deposits, a symposium [Stanford Univ., 1966]: Econ. Geology Mon. 4, 366 p., illus., tables, 1969.

This monograph includes 20 of the 23 papers, two discussions, and a summary presented at the symposium on magmatic ore deposits held at Stanford University on November 12 and 13, 1966. Seventeen papers are cited separately. — VSN

Wilson, H. D. B. *See* Kilburn, L. C. 09222

09264 **Wilson, H. D. B.; Kilburn, L. C.; Graham, A. R.; Ramlal, K.** Geochemistry of some Canadian nickeliferous ultrabasic intrusions, *in* Magmatic ore deposits, a symposium: Econ. Geology Mon. 4, p. 294-309, illus., tables, 1969.

The Katiniq ultrabasic sill in the Cape Smith-Wakeham Bay belt, Ungava Peninsula, Quebec, was intruded as a liquid-crystal mixture. Cumulus silicate minerals accumulated at the center of a flow system; more dense cumulus sulfide liquid accumulated near the bottom of the sill and collected in riffle-shaped traps to form ore bodies. The igneous series rose through the crust along the boundary between the Churchill and Superior provinces of the Canadian shield. Ultrabasic rocks in the Bucko and Bowden deposits of Manitoba nickel belt were intruded as a crystal mush with much lower liquid content than the Katiniq sill; silicate and sulfide phases show little evidence of gravity settling. The McWatters, Ontario, deposit, in a volcanic environment, was intruded as a liquid-crystal mush with enough liquid to allow segregation

of cumulus olivine toward the center of a dike flow-system, and gravity settling of cumulus sulfide liquid. — *from* Authors' abstract

09389 **Wilson, H. H.** Mullite formation from the sillimanite group minerals: Am. Ceramic Soc. Bull., v. 48, no. 8, p. 796-797, illus., 1969.

The rates of mullite formation from sillimanite, andalusite and kyanite were investigated over a range of temperatures. Effects of other variables such as grain size and impurities were also studied. — Author's abstract

09540 **Wilson, J. Tuzo.** Static or mobile earth, the current scientific revolution [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 600-601, 1969.

09570 **Wilson, J. Tuzo.** Aspects of the different mechanics of ocean floors and continents, *in* The World Rift System — Internat. Upper Mantle Comm. Upper Mantle Project Sci. Rept. 19: Tectonophysics, v. 8, nos. 4-6, p. 281-284, 1969.

The concept of ocean-floor spreading as currently accepted implies that the mechanics of ocean floors and of continents are different in character. It has been shown (Wilson, 1965; Sykes, 1967) that direction of motion on large submarine faults intersecting midocean ridges is the reverse of that expected in ordinary transcurrent faults. A Proto-Atlantic Ocean is suggested to explain the separation of contemporaneous realms of *Olenellus* and *Paradoxides* in North America and Europe, which indicates recurrent continental drift and repeated opening and closing of ocean basins. A pattern of convection currents within the mantle does not account for this behavior; instead the rigid lithospheric plates themselves form the outward current away from midoceanic ridges and the return flow is the only flow occurring in the asthenosphere. Midoceanic ridges should, therefore, be regarded as diapiric structures rather than as parts of a convective system. — *from* Author's abstract

09145 **Wilson, John E.** Sensor detection capabilities study: U.S. Geol. Survey Circ. 616, 26 p., illus., tables, 1969.

This report summarizes results of a study in which 10 sensor devices were investigated and rated on effectiveness in identifying characteristics of 98 earth resources targets; of geologic interest are drainage systems, earthquake areas, estuaries, flood areas and plains, gross geologic structures, ice, hot springs, lakes, linearities, minerals and petroleum exploration, mining, quarries, rock types, sand and gravel pits, shorelines, snow pack, soil, stream channels, water, and wells. Of the 98 targets, 89 indicated that a photographic system held the greatest promise of object detection. Infrared, side-looking radar, scatterometer, and passive microwave each were capable of significant contributions over one or more of the targets. Sensor evaluation indicated little spaceborne capability for extant devices other than photography, which reflects the need for continuing sensor improvement and investigation into uses of "as is" imagery. — MCM

Wilton, C. K. *See* Carrington, J. K. 09474

Witherspoon, P. A. *See* Sahores, J. J. 09519

Wolaver, Thomas G. *See* Blackman, Abner. 01899

Wold, Richard J. *See* Smith, Robert B. 01982

09439 **Woodrow, Donald L.; Blackburn, Thomas R.; Monahan, Edward C.** Geological, chemical, and physical attributes of sediments in Seneca Lake, New York, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 380-396, illus., tables, 1969.

In Seneca Lake, coarse-grained, heterogeneous sediments cover the bottom near the shoreline; fine-grained, cohesive clays occur on the slopes, and very fine-grained,

noncohesive muds are on the floor of the deep lake. Values of chemical and physical parameters are contoured and parallel the bathymetric contours. Oxygen values are highest near shore and sulfide and chloride are highest in deep lake sediments. Sediment density ranges from 1.85 nearshore to 1.05 in the deep lake. Seismic data indicate the bedrock profile is a broad 'V', and sediment thickness varies from O nearshore to 600 feet in the lake axis. A complex series of lake-filling events is indicated, but the presently operative processes of clastic transport appear to account for much of the younger material making up the fill. — *from* Authors' abstract

09141 **Woollard, G. P.; Machesky, L. F.; Longfield, R. L.** Results for a series of north-south gravity control traverses in the United States: Hawaii Inst. Geophysics [Rept.] HIG-69-22, 17 p., unpaged tables, 1969.

Approximately 1600 gravity stations were established along 10 N-S lines in the United States during the summer of 1967. Principal facts (station number, latitude, longitude, elevations, observed gravity, free-air anomaly, and Bouguer anomalies) are tabulated for each station. Observations were at approximately 10-mi intervals and were made using ground transportation. A new airport gravity base network was established by the Air Force 1381 Geodetic Survey Squadron to use as control for the N-S profiles; data are tabulated and station descriptions are given. An evaluation is given of the reliability of results reported for the airport gravity base net. — VSN

09523 **Woollard, G. P.** Relation of gravity to regional changes in surface elevation [abs.], *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 403, 1969.

Woollard, George P. *See* Khan, Mohammad Asadullah. 02129

02002 **Wright, F. F.** Turbid layer sedimentation in Alaskan fiords [abs.]: EOS, v. 51, no. 4, p. 335, 1970.

09362 **Wright, H. E., Jr.** Glacial fluctuations and the forest succession in the Lake Superior area, *in* Conference on Great Lakes research, 12th, Ann Arbor, Mich., 1969, Proc.: Ann Arbor, Mich., Internat. Assoc. Great Lakes Research, p. 397-405, illus., 1969.

The Superior ice lobe advanced four separate times out of its basin between about 16,000 and 12,000 years ago, for successively shorter distances; the last two may reflect surges. The terrain near the Superior lobe was marked by tundra until about 10-11,000 years ago, when spruce forest invaded from the south. Little in the pollen sequence suggests climatic fluctuations that can be correlated with ice-margin fluctuations. Jack or red pine expanded into the area from the east 10,000 years ago, followed by deciduous trees with prairie openings, culminating about 7,000 years ago. Subsequently a reversal in climatic trend has brought the return of conifer forest and the development of bogs. — *from* Author's abstract

09467 **Wright, J. D.** Kaolinite clay deposits in the Musquodoboit Valley, Nova Scotia [abs.]: Canadian Mining and Metall. Bull., v. 62, no. 683, p. 197 1969.

02003 **Wright, Robert J.; Manuel, O. K.; Miller, D. K.** Xenon and krypton from step-wise heating experiments in carbonaceous chondrites [abs.]: EOS, v. 51, no. 4, p. 339-340, 1970.

02004 **Wu, Francis T.; Kanamori, Hiroo.** Body and surface waves source mechanisms of the 1965 Rat Island earthquake [abs.]: EOS, v. 51, no. 4, p. 355, 1970.

09529 **Wyllie, Peter J.** The origin of ultramafic and ultrabasic rocks, *in* Deep-seated foundations of geological phenomena — Upper Mantle Proj. Sci. Rept. 24 (based on Upper Mantle Symposium, 23d Internat. Geol. Cong., Prague, 1968): Tectonophysics, v. 7, nos. 5-6, p. 437-455, table, 1969.

Ultramafic rocks are classified in terms of field associations and tectonic environment. Eleven associations are distinguished, some with subdivisions. The major features of each association are described in turn, and it is emphasized that the variety of field and petrographic associations indicates that a variety of processes is involved in origin and emplacement of these rocks. For petrogenetic discussion associations are considered in three groups: (1) layered, stratiform and other intrusions involving gabbro or diabase together with accumulations or concentrations of mafic minerals; (2) alkalic rocks of stable continental regions, including kimberlites, mica peridotite, ring complexes, and ultrabasic lava flows; (3) the several peridotite-serpentinite associations of orogenic belts that have been classified as alpine-type intrusions. Petrogenesis of ultramafic nodules in alkali basalts and kimberlites is discussed also. — *from* Author's abstract

02005 **Wyss, Max; Brune James N.** Moments, energies, and dimensions of earthquakes with magnitudes from 1 to 3 [abs.]: EOS, v. 51, no. 4, p. 357, 1970.

09327 **Yacuzzo, Raymond E.** A reconnaissance of the ground-water geology of Montville Township, Medina County, Ohio: Compass, v. 46, no. 4, p. 207-216, illus., table, 1969.

The reconnaissance indicates that potable water is available in varying amounts from both bedrock and glacial deposits. Most of the bedrock consists of shale which yields from 1 to 50 gpm to small diameter wells. Higher yields are obtained from those wells along walls of the major valley trending north-south in the eastern part of the area. Yields can only be increased slightly by deepening the wells beyond a depth of 100 feet. Specific capacity of bedrock wells can attain 2 gpm but many yield less than 1/2 gpm per foot of drawdown. Several wells are contaminated with saline water which locally reaches a concentration of 150 ppm of chloride. The glacial deposits are not important sources of ground water in the township. — *from* Author's abstract

02006 **Yang, Tsung.** The concept of entropy in stream morphology [abs.]: EOS, v. 51, no. 4, p. 278, 1970.

02168 **Yardley, D. H.** Public works create great demand for geological engineering services: Mining Eng., v. 22, no. 2, p. 80-81, illus., 1970.

This article reviews some engineering geology projects undertaken in 1969, including a stabilization evaluation of Niagara (American) Falls, site-environmental studies for nuclear power plants, and highway engineering studies in varied geological environments. Rock mechanics courses and research projects at several universities are described. A review of pertinent meetings and publications is also included. — MAC

09462 **Yegiazarov, Boris Khristoforovich.** Geologicheskoye stroyeniye Alyaski i Aleutskikh ostrovov (sravnitel'naya kharakteristika s sopredel'nymi regionami severovostoka Azii) [Geologic structure of Alaska and the Aleutian Islands (relationships with adjacent regions of northeastern Asia)]: Leningrad, U.S.S.R., Nauchno-Issled. Inst. Geologii Arktiki, 264 p., illus., geol. maps, 1969.

The asymmetric structure of the north Pacific region reflects a complex history of sedimentation, magmatic activity, and crustal deformation within migrating Mesozoic and Cenozoic geosynclinal troughs. Structural characteristics of zones of folding, their relations with Precambrian-early Paleozoic basement fault blocks and platforms, and development of continental and oceanic structures are analyzed with reference to the regional pattern. Analysis of the tectonic style of Paleozoic and Mesozoic structural complexes of Chukchi (Asiatic U.S.S.R.), northern Alaska, and Arctic Canada indicates a continuous miogeosynclinal system whose development was controlled by a deep-seated transverse fault, the Lena-Mackenzie fault. Younger structures also exhibit effects of deep-seated transverse faults. The Precambrian to Quaternary stratigraphy is outlined. Correlation charts and a colored geologic map 1:2,500,000 of Alaska, the Aleutians, and northwest Canada accompany the monograph. — MS

Yemel'yanov, Ye. M. *See* Anoshin, G. N. 09229

Yoder, H. S., Jr. *See* Huckenholz, H. G. 09416

09577 **Yoder, H. S., Jr.** Experimental studies bearing on the origin of anorthosite, *in* Origin of anorthosite and related rocks: New York State Mus. and Sci. Service Mem. 18, p. 13-22, illus., 1968 [1969].

Plagioclase components may be concentrated at high pressures under anhydrous or hydrous conditions in a liquid which, if brought undifferentiated into the crust, would crystallize as anorthosite. In a similar way, partial melting of natural basalts in the presence of water generates liquids very rich in plagioclase components at relatively low pressures and temperatures. These conditions do not differ greatly from those required for production of syenite or granite liquid. Subsolidus reactions of plagioclase with orthopyroxene or olivine at high pressure restrict the generation of anorthosites to the crust. Studies on the ternary feldspars show that liquids in equilibrium with plagioclase and alkali feldspar are marked by early separation of plagioclase to form anorthosite with a syenite or monzonite residuum. A process for formation of anorthosite is proposed in which a liquid of anorthositic composition with water as an essential component is generated from basic mantle material under high pressure and moderate temperature. — JWC

York, D. *See* Baksi, A. K. 01887

02214 **Youmans, A. H.; Bishop, W. Don; Wichmann, P. A.** Applications of the neutron lifetime log in new wells, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. N1-N20, illus., table, 1970.

The NLL has been used extensively for evaluation and recompletion of old wells, but examples demonstrate the value of running the log when a well is first completed or even before casing is set to observe progressive changes in fluid saturation under conditions where the log would otherwise have little value. Another application is comparison of logs in open hole with those run at varying intervals subsequent to casing, cementing and production to identify permeable zones and measure progressive changes in saturation whenever the different fluids have differing thermal neutron capture characteristics; residual oil saturation can be measured to identify immovable hydrocarbon deposits or establish water flood sweep efficiency for planning tertiary recovery projects. Examples are cited where logs in open holes or in newly completed wells are recommended. — *from* Authors' abstract

09463 **Young, Maurice J.; Aird, C. A.** Geology of the Gem molybdenum deposit: Canadian Mining and Metall. Bull., v. 62, no. 681, p. 41-45, illus., 1969.

The prospect, at the headwaters of Clear Creek, is about 30 miles north of Harrison Hot Springs, British Columbia. The creek follows a deeply eroded fault zone southwesterly. The area is underlain by schists and gneisses in a broad fold plunging steeply to the northeast, intruded by numerous bodies of granodiorite. A granite plug has intruded the fold just west of Clear Creek and encloses a circular breccia pipe in which fragments of metamorphic rocks, granite, and quartz monzonite porphyry are cemented in a matrix of quartz monzonite porphyry. All of these are cut by numerous fractures filled with vuggy quartz veins, many containing molybdenite. Since 1964, exploration has been directed toward outlining a large, low-grade type of molybdenum deposit. — *from* Authors' abstract

Yund, R. A. *See* Kullerud, G. 09223

02090 **Zakrzewski, Richard J.** Notes on kangaroo rats from the Pliocene of southwestern Kansas, with the description of a new species: Jour. Paleontology, v. 44, no. 3, p. 474-477, illus., tables, 1970.

Remains of kangaroo rats from Pliocene deposits of southwestern Kansas include those of a new species, *Prodipodomys griggsorum*, from the Saw Rock Canyon local fauna. Small samples of *P. rexroadensis* from two localities of the Rexroad local fauna that show differences in maxillary alveolar measurements, supplemented by other data, suggest the possibility of establishing a relative time sequence between localities within the Rexroad local fauna. — Author's abstract

02211 **Zanier, Aldo M.; Overton, Harold L.** Use of acoustic logging technique for determination of intergrain cementation properties, *in* SPWLA Logging Symposium, 11th Ann., Los Angeles, Calif., 1970, Trans.: Houston, Tex., Soc. Prof. Well Log Analysts, p. K1-K11, illus., tables, 1970.

Techniques of determining formation resistivity factor include formulas of Archie and Humble which use an empirical method for determining m, where high porosity materials, such as sandstones, have small m, and low porosity materials, such as limestone, have large m. In Archie's formula, m, the cementation factor, varies with degree of consolidation of rocks and ranges from 1.3 to > 3; the value of m is chosen from lithologic description of the rock. Acoustic velocity of dilatational and shear waves in rocks increases as hydrostatic pressure increases. For dilatational waves the rate is a function of packing of grains, while for shear it is a function of shear coupling. Shear waves are sensitive to cementing material, dilatations are mainly dependent upon grain properties. A theoretical exponent n has been derived and tested experimentally, dilatational and shear wave tests have been made, and bulk compressibility and shear strength recorded under confining conditions. Tests indicate a relation between n and the cementation factor. — *from* Authors' abstract

02007 **Zietz, Isidore; Andreasen, Gordon E.; Cain, J. C.** Magnetic anomalies from satellite magnetometer [abs.]: EOS, v. 51, no. 4, p. 268, 1970.

02008 **Zimmerman, Herman B.; Hollister, Charles D.** Contour currents on the continental rise [abs.]: EOS, v. 51, no. 4, p. 336, 1970.

09369 **Zlatkis, Albert; Bruening, Wilhelm; Bayer, Ernst.** Determination of gold in natural waters at the parts per billion level by chelation and atomic absorption spectrometry: Anal. Chemistry, v. 41, no. 12, p. 1692-1698, illus., tables, 1969.

The method uses a polyschiff base in a column which specifically chelates gold. Concentrated metal is eluted from the chelate and determined by atomic absorption. — AC brief

09255 **Zumberge, James H.; Benninghoff, William S.** A mid-Wisconsin peat in Michigan, U.S.A. [with French abs.]: Pollen et Spores, v. 11, no. 3, p. 585-601, illus., tables, 1969.

At Grand Rapids, Mich., a 1-m-thick peat bed forms the top of a 6-m lacustrine sequence of laminated clays and bedded sands (John Ball Park beds) which lies stratigraphically between two till units. The peat layers are strongly deformed by glacial overriding and contain abundant fragments of larch wood C-14 dated at > 36,000 to > 40,000 years. The pollen spectra are dominated by spruce and indicate a uniformly cool climate throughout the period of lake filling. C-14 dates, pollen spectra, and pebble lithology of the tills indicate a post-Sangamon pre-"classical" Wisconsin age for the oldest till unit, and correlation of the lake beds with the Port Talbot interstade, which is regarded as a significant period of deglaciation between early and "classical" Wisconsin time. Wisconsin-age beds older than the Cary Substage have not been recognized before in Michigan. — VMJ

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